NO. 1 CROSSBAR SWITCHING SYSTEM

VOLUME I

No. 1 CROSSBAR SWITCHING SYSTEM

VOLUME I

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CHAPTER 1

SECTION 1

GENERAL DESCRIPTION
The No. 1 Crossbar Dial Office

MARCH 1954

THE CROSSBAR DIAL SYSTEM

There are three dial systems in general use in the Bell System today, the step-by-step, the panel and crossbar dial systems. Although the two earlier systems are quite satisfactory and represent definite advances in the telephone art it is expected that the crossbar system will offer certain important advantages such as lower maintenance cost, shorter call completing times, and better transmission characteristics due to the use of precious metal contacts.

The crossbar dial system has been developed in its present forms for use in large metropolitan area using the No. 1 crossbar system and for smaller communities using the No. 5 crossbar system. Two other crossbar systems are in use today, the crossbar tandem and No. 4 toll systems. These two latter crossbar systems are used in conjunction with all telephone systems when required for completion of calls. The crossbar dial system No. 1 and No. 5 will operate with existing panel offices and with existing call indicator, tandem and toll installations. The same classes of service available to the public in panel offices will also be available to the public in the No. 1 and No. 5 crossbar offices. Complete interconnection of equipment between crossbar and manual has been provided in all respects.

The switching apparatus and the method of setting up calls in a No. 1 crossbar office differ in principle from those of either the step-by-step or panel systems. These two systems employ mechanical hunting for the various switching functions. This motion is furnished by magnetically operated ratchets as in the step-by-step system or by power driven rods as in the panel system. These devices cause brushes to wipe over contacts in either rotary or linear motion to set up the desired electrical connections. Base metal is generally used for the contacting material in the mechanism of these systems.

The crossbar dial system is different from panel and step-by-step in that it is essentially a relay system. Mechanical motion has been largely reduced so as to be comparable to that required to close or open contacts in relays used in telephone systems. Precious metal contacts are employed for all circuit closures.

The system, in general, employs apparatus as follows: the crossbar switch, multicontact relay, and the U and Y type relays. The only power driven apparatus, aside from the power supply machines, are reciprocating bar interrupters similar to those used in the panel system, and certain new self-continued timing mechanisms used for the timing of telephone calls.

RELAYS

The Crossbar Switch

RM 001, RM 002, RM 1-1 and RM 1-2 illustrate what is known as a "200 point crossbar switch". The crossbar switch is manufactured in 2 sizes, 100 and 200 point switches. In principle they are relays with 100 or 200 sets of contact springs, each set of springs capable of being operated independently of any other set. These sets of contacts are arranged in a rectangular field of ten horizontal rows and ten or twenty rows and are operated by horizontal and vertical bars. The horizontal bars are controlled by "selecting" magnets and the vertical bars by "holding" magnets. Briefly, any set of contacts may be closed by the operation of the selecting magnet which determines the horizontal row, followed by the operation of a"holding magnet" which determines the particular set in that row. The set of contacts then remains operated under the control of the "holding magnet," the selecting magnet being permitted to release.

The operating principle of the crossbar switch is shown in some detail in the illustration on RM 1-3, RM 1-4, RM 004, and RM 005.

The Multicontact Relay

The multicontact relay used in the crossbar system, as illustrated on RM 006 resembles in design the vertical unit of a crossbar switch. This relay is made up of an assembly of two relays on a common mounting, since each half of a relay has its own separate magnet, armature, and group assemblies. Each structure may therefore be used as two independent relays or when desired used as one relay by multipling the two windings of the coils. All contacts are make contacts.

The multicontact relay finds its chief application where a large number of leads must be connected from one circuit to another. Two types of this relay are available, one for multiple wiring of contacts and the other for individual wiring of contacts.

Multicontact Switch

Whenever it is necessary to switch a large number of leads manually the multicontact switch is used. In certain transfer circuits as from one control circuit to another the hand operated switch is valuable. This switch is essentially a multicontact relay with magnets omitted and replaced by a lever or key for actuating a plate which takes the place of the armature in multicontact relays.

"U" & "Y" Type Relays

A new and improved general purpose relay is used in the crossbar dial system. This relay is shown in RM 003 and although somewhat similar to the familiar "E" and "R" type relays, differ from the latter principally in that it has a heavier and more efficient magnetic structure which permits the use of a greater number of contact springs. These relays are equipped with twin contacts as are the crossbar switch and multicontact relays.

A variation of this relay, known as the "Y" type, RM 003 is similar in appearance to the "U" type but is designed to be slow acting.

CROSSBAR SYSTEM FUNDAMENTALS

The fundamental method of using the crossbar switch in setting up connections is illustrated on RM 008, Fig. A. This figure shows ten lines connected to the ten verticals of a 100 point crossbar switch and ten trunks strapped horizontally across the switch. With such a combination, any one of the ten lines may be connected to any one of the ten ~~trunks~~ Links. This principle, with variations, is employed on all the major crossbar system frames.

With the arrangement shown on RM 008, Fig. A, any line would always be able to find an idle ~~trunk~~ Link, since the number of lines coming into the switch is exactly equal to the number of ~~trunks~~ Links going out, and no busy condition would ever be encountered. This is not an efficient condition, however, since the calling rate on the lines involved would have to be heavy in order to use the ten ~~trunks~~ Links to capacity.

RM 008, Fig. B shows a means of using the same ten ~~trunks~~ Links in a more efficient manner. A second 100 point crossbar switch has been added, this crossbar switch having ten different lines connected to its verticals. The horizontal multiple across the second switch has, however, been connected to the horizontal multiple of the original switch of RM 008, Fig. A so that now twenty lines have access to the ten ~~trunks~~ Links instead of only ten lines. By adding other switches in this manner, any number of lines may be given access to ten ~~trunks~~ Links. It is also possible to use 200 point crossbar switches in the same manner to give two or more groups of twenty lines access to ten ~~trunks.~~ Junctors.

Obviously, the usefulness of the crossbar system would be very small if it were limited to only ten ~~trunks,~~ Junctors for although any number of lines could be added to the system by multipling other switches the point would soon be reached where the ten ~~trunks~~ Junctors would be overloaded. It would be possible, of course, to double the capacity of the system by duplicating the arrangement of RM 008, Fig. B thus providing twenty ~~trunks~~ Junctors in all. Such an arrangement would not be entirely satisfactory, since each group of lines would still have access to only ten ~~trunks.~~ Junctors In order to obtain greatest efficiency, it is necessary to provide all of the lines with access to all of the ~~trunks.~~ Junctors

Such access is provided through the use of the "primary-secondary" switch principle, which is fundamental in the crossbar system and illustrated on RM 009. The "primary" switches are arranged in a manner similar to that shown on RM 008, the trunks multipled horizontally on these switches being connected to the horizontal terminals of a group of switches known as "secondary" switches. The groups of trunks to which it is desired to connect the various lines are now wired to the verticals of the secondary switches. The connections between the horizontal terminals of the primary switches and the horizontal terminals of the secondary switches are referred to as "links". Any one of twenty lines can now have access to any one of twenty trunks via these links. It should be noted, however, that this access is limited, because if all five links between a primary and secondary switch were busy a given line on the primary switch would not be able to reach an idle trunk on that particular secondary switch.

The arrangement shown on RM 009 is introduced merely to illustrate the primary and secondary switch principle and is not used, in the form shown, in the crossbar system. RM 010 illustrates the principle of primary and secondary switches used in various forms on nearly all the major crossbar frames. RM 009 shows five links from each primary to each secondary switch. The result of this combination is that any line on any primary switch has limited access to any one of 100 outgoing trunks, with the advantage of obtaining the greatly increased traffic efficiency of the 100 trunk group over a number of ten or twenty trunk groups.

The arrangement shown on RM 010 is that employed on the line link frame in order to give a group of 100 lines access to 100 ~~trunks~~ Junctors. The links between primary and secondary switches are referred to as "line links" in this case. The number of lines having access to the 100 outgoing ~~trunks~~ Junctors is increased in size by adding other primary switches with their horizontal terminals in multiple with the primary switches shown on RM 010. Each group of primary switches having access to the same ten line links is referred to as "a horizontal group" and each horizontal group should contain the same number of lines.

PRINCIPAL EQUIPMENT

(Compared to Panel)

A comparison of some of the major crossbar frames with panel frames will be given. Keeping this comparison in mind will assist in the understanding of the No. 1 crossbar system. Crossbar frames which perform similar functions to the various panel frames may be enumerated as follows:

Panel	Crossbar
Line Finder	Line Link
District	District Link
Subscribers Link	Subscribers Sender Link
Subscribers Sender	Subscribers Sender
Office	Office Link
Decoder	Originating Marker
Incoming	Incoming Link
Final	Line Link

Although there are additional frames to those mentioned above, the comparison shown will be an aid to a better understanding of the crossbar dial system.

(Nomenclature)

Before proceeding it will be necessary to define some of the terms related to the crossbar system. Familiarity with these terms and definitions is necessary for a clear understanding of a crossbar system call.

Each major crossbar system frame employs a "primary-secondary" arrangement of switches similar to those shown in RM 009 and RM 010. On each frame the connection between the primary and the secondary switch is referred to as a "link" and the link is further described by the name of the frame on which it appears. Thus *line* link, *district* link, *office* link *incoming* link, *subscribers* *sender* link and the *terminating* *sender* link frames.

In the previous discussion of primary-secondary combinations shown in RM 009, the ~~trunks~~ Junctors are shown on the secondary switches. Where these trunks go to a succeeding crossbar frame they are referred to as "junctors". Each type of junctor takes its name from the frame to which it is going. Thus, junctors from the line link secondary switches to the district link primary switches are referred to as "district junctors." Junctors from the district link secondary switches to the office link primary switches are called "office" junctors. Junctors from the incoming link secondary switches to the line link secondary switches are called "line" junctors. The exception to this general rule is found in the case of incoming trunks which are outgoing from office link secondary switches and incoming to incoming link primary switches.

Associated with each type of junctors are distributing frames where the various cross connections between frames can be made.

A particular set of contacts on a crossbar switch is referred to as a "crosspoint", this being the particular set of contacts closed by the operation of a "selecting magnet" and a "holding magnet."

(Frames)

As an introduction to the study of a No. 1 crossbar dial system some knowledge of the major crossbar system frames is necessary. RM 013 illustrates a path of a crossbar call. In studying the description of these frames it will be found helpful to keep the functions of the compared panel frames in mind. Discussion of the manner in which the frames themselves function in handling calls will be discussed after the frames have been described.

Line Link Frame

The crossbar system line link frame performs, in general, the functions of the line finder and of the final frames of the panel system.

The trunking arrangement of the line link frame is illustrated schematically on RM 011. It employs the primary-secondary arrangement of crossbar switches previously described. The line link frame is used both in originating and terminating calls. An originating call is set up from the particular vertical on a primary switch on which the calling line appears, through a line link to a secondary switch and thus to an idle district junctor which appears on a vertical of a secondary switch. Since the 100 line links from primary switches are distributed over all secondary switches and there are a total of 100 district junctors to which a particular line link frame has access, any calling line may be connected to any idle district junctor in the 100. To set up such a combination the primary and secondary selecting magnets corresponding to a particular line link must be operated followed by the operation of the primary holding magnet corresponding to the calling line and the secondary holding magnet corresponding to an idle district junctor.

In general, 200 point switches are employed as secondary switches on the line link frame. Ten of the verticals on each secondary switch represent district junctors which are used on originating calls. The remaining ten verticals of each secondary switch represent line junctors from the incoming frame, 100 line junctors having access to each line link frame.

These line junctors are used on terminating calls. It is obvious, therefore, that the same line links and the same primary switch verticals are used for both originating and terminating calls. Thus, the crossbar system line link frame corresponds to both the line finder frame and the final frame of the panel system.

Each line link frame has associated with it a "control circuit" whose function it is to recognize a calling line, choose an idle line link and assist in the selection of an idle district junctor and to operate the necessary selecting and holding magnets for connecting these paths together. On a terminating call it assists in setting up the call from the incoming trunk over a line junctor and line link to the called line.

District Frame Group

The district frame group includes the subscriber sender link, district junctor, and district link frames. Each such group of three frames serves 100 district junctors.

District Link Frame

The district link and district junctor frames together correspond to the district frame of the panel system.

The district link frame employs the primary-secondary arrangement of crossbar switches using ten 200 point primary switches and ten 200 point secondary switches. One hundred district junctors from line link frames are terminated on the 100 horizontal rows of contacts on the primary switches. Two hundred office junctors to the office link frames are terminated on the verticals of the secondary switches. The primary and secondary switches are interconnected by means of 200 district links appearing on the 200 vertical units of the ten primary switches and on the 100 horizontal rows of contacts of the ten secondary switches. Each horizontal row of contacts on the secondary switches accommodates two links, the strapping for each row being divided between the tenth and eleventh verticals (split horizontals). Thus, the ten district junctors which occupy the ten horizontal rows of contacts on a primary switch have access to twenty links which are distributed over ten secondary switches so arranged that twenty groups of office junctors (ten junctors each) are made accessible to them.

District Junctors

Each district junctor includes a relay circuit which provides talking battery and supervision for the calling subscriber and controls the operation of the subscriber message register on all calls dialed directly by subscribers. These functions are similar to those performed by the district circuit of the panel system and the "A" board cord circuit in the manual system.

Subscriber Sender Link Frame

Subscriber senders are selected for each call by the subscriber sender link frame, whose functions are similar to the link frame of the panel system. The subscriber sender link frame consists of primary and secondary switches whose function it is to connect an idle subscriber sender to the particular district junctor which has been selected for a given call. Since this frame must operate before the subscriber begins to dial and before the originating marker has been connected it must be provided with a control circuit. This control circuit assists the line link control circuit in choosing the particular district junctor to be used on the call and also determines which sender is available.

The terminating sender link frame performs a similar function to the subscriber sender link frame in connecting an idle terminating sender to the particular incoming trunk on terminating calls.

Subscriber Sender

The subscriber senders of the crossbar system are similar to and perform much the same functions as those of the panel system except that they do not control the setting up of the paths between the calling line and the outgoing trunk. On a call to a panel office, they will control the incoming and final selectors in the distant office on a revertive pulsing basis. On a call to another crossbar office, the required number will be passed to a full selector "terminating" sender in the distant office also by means of revertive pulsing. Calls to manual offices will be handled on a call indicator basis in the same manner as for panel subscriber senders.

Originating Marker

The originating marker of the crossbar system besides performing the functions of the panel decoder in "decoding" the office code dialed by the subscriber, also selects the combination of paths to be used between the calling line and the trunk to the particular office required. The originating marker selects an idle trunk to the office required. This determines the point on the office link frame to which the trunk to the desired office is connected. The marker also proceeds to connect this trunk to the district junctor on which the call is waiting by choosing an available combination of district link, office junctor, and office link suitable for making the connection. The marker is responsible for establishing the proper charge condition in the district junctor.

Office Link Frame

The office link frames are arranged in a manner similar to the district link frames. Each office link frame consists of a unit of ten primary switches and ten secondary switches all of the 200 point type. Two hundred office junctors from district link frames terminate on the vertical units of the office primary switches. Two hundred office links between the primary and secondary switches appear on the horizontal rows of terminals of the primary switches and on the 200 vertical units of the secondary switches. The strapping on each horizontal row of terminals on the primary switch is divided between the tenth and eleventh vertical units so that each row accommodates two links. The outgoing trunks appear on horizontal rows of terminals of the secondary switches and these rows of terminals of the secondary switches may or may not be split so that one row may serve either one or two outgoing trunks, depending upon the traffic density.

It is the practice in a crossbar office to assign the trunks to a given office to two different office frames. This insures that if a trouble condition occurs on one office frame a call to a given office will be completed over a trunk available through the second office frame.

Incoming Frame Group

The terminating sender link, incoming trunk, and incoming link frames are grouped in a manner similar to that for the district frame group. Each such group of three frames serves 100 incoming trunks.

Incoming Link Frame

The incoming link and incoming trunk frames together correspond to the incoming frame of the panel system.

Incoming trunks appear on the horizontals of the primary switches on incoming link frames. The line junctors which are used to connect the incoming link frame to the line link frame for terminating calls appear on the verticals of the secondary switches. Between the primary switch verticals and the horizontals of the secondary switches are wired incoming links. On a terminating call it is, therefore, necessary to choose an incoming link, a line junctor, and a line link in order to complete a call between a particular incoming trunk and the desired called line.

Incoming Trunks

Each incoming trunk includes a relay circuit which provides talking battery and supervision for the called subscriber where required and rings the called subscriber bell. These functions are similar to those performed by the incoming selector of the panel system and the incoming trunk of the manual system.

Terminating Sender Link Frame

The terminating sender link frame connects an idle full selector or "B" sender to the particular incoming trunk on terminating calls.

Terminating Senders

Terminating senders are of two kinds: Full Selector and "B" Senders.

A call from a panel or crossbar office will be registered in a full selector sender. In either case the sender registers the call by means of revertive pulses to the sender in the originating office. If the call is from a manual office the manual "A" operator will pass the number to a "B" operator in the crossbar office who will in turn transmit it by key set to a "B" sender.

Terminating Marker

The function of the terminating marker is to connect the call waiting on an incoming trunk to the called line by choosing an available combination of incoming link, line junctor, and line link for making the connection. As soon as the terminating sender has registered the number, it connects itself to a terminating marker and passes the number to the marker. This information is used by the marker to determine the location of the called line. The marker also establishes the proper ringing condition in the incoming trunk.

Number Group Connector and Block Relay Frames

From the digits of the called number the marker determines the "number group" in which it is located. A number group is a group of numbers, varying in size with traffic conditions which the marker treats as a unit. Having obtained access to the number group through the number group connector frame the marker also proceeds to operate a "twenty block" relay on a block relay frame representing the block of twenty consecutive numbers containing the called line. From the block relay, the marker obtains information as to the location of the line on the line link frame.

Line Choice Connector and Line Junctor Connector

After determining the location of the called line the terminating marker obtains connection to the particular line link frame and the particular group of line junctors necessary for the call through the line choice connector and line junctor connector frames. A line choice is the association of four line link frames which are treated as a unit by the marker in setting up terminating calls.

Connectors

The district and office link frames are controlled by the originating marker and hence do not require their own control circuits. They are, however, provided with "connectors" consisting of relays mounted on each district and office link frame which enable the originating marker to gain temporary access to these frames and exercise the necessary control. An incoming link frame is also provided with a connector giving access to the terminating marker.

In order to permit originating senders to obtain access to originating markers, each sender is wired to an "originating marker connector" frame through which it may be connected to an idle marker. Terminating senders obtain access to terminating markers through "terminating marker connector" frames.

Having described the functions of the various frames separately, it is now possible to take up the interrelation of these frames in handling originating and terminating calls as illustrated schematically on RM 012.

BASIC CIRCUIT OPERATION

(Originating Calls)

With the exception of the line link frame, the crossbar equipment for originating calls is entirely separate from that used for terminating calls. This part will deal only with the originating equipment and will show how a calling subscriber line is found and connected to an idle outgoing trunk to the required office. The general procedure for this part of the call is the same regardless of whether the distant office is crossbar, panel, or manual.

(Crossbar - A Marker System)

The panel and step-by-step systems set up a call on a "hunting" basis. As soon as an idle path, going in the proper direction, is found, the path is seized and immediately used to progress to the next diverging point, where this operation is repeated.

The crossbar system sets up its calls on a "marker" basis. The establishment of a call is broken up into four general steps (two in the originating and two in the terminating equipment) and the termination of each step is "marked" before any of the intervening paths are actually seized. In the first step in the originating equipment, the subscriber sender to be used on a particular call is chosen before the line link, district junctor, and sender link are connected to the subscriber line. In the second step, the outgoing trunk is chosen before the district link, office junctor, and office link are tested. The third and fourth steps, in the terminating equipment, are connecting an idle terminating sender to the incoming trunk and connecting the called subscriber to the incoming trunk.

Finding the Calling Line

Each subscriber line terminates on a vertical unit of a line link primary switch and the line relay associated with each line is located immediately beneath the corresponding switch. When the calling subscriber receiver is removed from the switchhook, the line relay is operated as in other systems.

Before the subscriber can proceed to dial the required number, however, he must be connected to a sender and must receive dial tone. The line link frame and the subscriber sender link frame are responsible for setting up this connection, that is, for connecting the calling line to an idle district junctor and also for connecting the district junctor to an idle subscriber sender.

As previously stated, there is associated with each line link frame a control circuit. This circuit is caused to function by the operation of any line relay on the frame. Each line has access to only ten line links so that the control circuit must recognize which line is calling and then connect that line to an idle line link by operating the proper primary switch selecting magnet and holding magnet.

The line link control circuit identifies the horizontal group (the primary switches having access to the same ten line links) in which the calling line appears and then the vertical group (the 100 lines represented by ten primary switches mounted directly one above the other). These two identifications show in which ten lines on the line link frame the calling line appears, as may be seen from RM 014, Fig. A. The control circuit tests this group of ten lines for the operated line relay and thus determines which primary holding magnet is to be operated.

The control circuit also tests the ten line links of the horizontal group in which the calling line appears and chooses one which is idle. This choice is made in conjunction with the sender link control circuit. Since each line link horizontal group has only one line link to each group of ten district junctors, which of the idle line links is to be used will depend upon which group of ten district junctors is to be used for the call. By operating the various primary selecting magnets associated with the line link followed by the operation of the line holding magnet, the calling line may be connected to an idle line link, as shown schematically on RM 014, Fig. B.

It will also be necessary to connect the line link to an idle district junctor. As stated above, a particular line link has access through the secondary switch on which it appears to ten district junctors. The line link control circuit chooses one of these ten district junctors which is idle. The line link may be connected to the district junctor by the operation of the holding magnet associated with the district junctor. By means of RM 014, Fig. B, the calling line may now be traced through a line link to a district junctor. This is comparable with the panel condition where the line finder has found the calling line and extended it to a district selector.

Seizure of Subscriber Sender

Before the process of choosing an idle district junctor, the subscriber sender link frame associated with the district frame on which the chosen district junctor appears has selected an idle subscriber sender.

The control circuit on the subscriber sender link frame assisted the line link control circuit in choosing an idle district junctor. This district junctor appears on the vertical of the primary switch on the subscriber sender link frame as well as on the secondary switch of the line link frame. The subscriber senders are wired to the horizontals of the secondary switches. The control circuit must choose an idle sender and operate the secondary selecting magnet associated with the horizontal terminals on which this sender appears and the primary selecting magnet associated with the horizontal terminals on which the sender link appears. The operation of the primary holding magnet associated with the sender link will connect the district junctor to the idle sender.

As soon as the line link, district junctor, and subscriber sender to be used on the call have been determined, the necessary magnets required to connect the calling line to the sender are operated. The calling subscriber will now receive dial tone over the path provided by the line link, the district junctor, the subscriber sender link and the sender (see RM 014, Fig. B).

Action of Sender

As soon as the subscriber has received dial tone he will proceed to dial the number required. This, as in the panel system, is recorded in the sender. As soon as the sender has recorded the complete office code it proceeds to connect itself to an idle originating marker. This is done by means of an originating marker connector (see RM 015, Fig. A), which is similar in principle to the decoder connector of the panel system. As soon as the sender is connected to the marker it transmits the office code dialed by the subscriber (together with the district frame and class of service indications) to the marker.

The originating marker in turn gives the sender information which it will need for controlling the path of the call in the terminating office. This includes information as to whether the terminating office is panel, manual, or crossbar but does not include information concerning the routing of the call to an outgoing trunk since this part of the call is handled by the originating marker itself and not by the sender.

Selection of Idle Outgoing Trunk

The next task of the originating marker is to locate an idle trunk to the office indicated by the office code. In order to accomplish this it connects itself to the pair of office frames on which the required outgoing trunks appear. This it does by means of an "office connector" located on the office frame (see RM 015, Fig. A). The office connector consists of a group of relays which permits the marker to connect itself momentarily to the test leads of any trunk group. The marker then proceeds to test the trunks on both office frames testing one on one frame and then one on the mate office frame until an idle trunk is found. The next problem is to connect this idle trunk to the district junctor on which the call is waiting.

Channel Testing

In order to connect the district junctor, on which the call is waiting to the idle outgoing trunk, which has just been chosen ("marked") by the marker, three paths must be connected in series between the two points. First, there must be an office junctor between the district and office frames. Second, the district junctor must be connected to an office junctor by means of a district link. Third, the office junctor must be connected to the outgoing trunk by means of an office link (see RM 015, Fig. A). Since there are a number of each of these paths which can be used on a given call it is the duty of the marker to determine which set of three paths shall be used.

The decoder marker connects itself to the test leads of outgoing trunks (as previously stated) and also to those of office links through the office connector. It obtains access to the test leads of district links and office junctors through the "district connector" located on the district frame on which the calling district appears (see RM 015, Fig. A). The proper district link frame is seized by the marker under control of the district frame indication received from the sender. The district and office connectors also provide the marker with access to the leads for operating the necessary magnets.

In the originating marker there are two "channel test" relays for each combination of three paths (district link, office junctor, and office link). If either relay is operated, the particular combination of three cannot be used. In order to notify the marker if any one of the three paths is busy the test lead for each path is connected to a different winding on the channel test relays. By means of these windings any path can indicate to the decoder immediately whether it is busy or not and if one of the three is busy the marker can proceed to find the set of three idle paths which can be used for the call.

Connecting to Outgoing Trunk

As soon as the marker has satisfied itself that a particular set, including a district link, office junctor, and office link is available to connect the calling district to an outgoing trunk, it proceeds to operate first the district and office selecting magnets and then the necessary holding magnets to connect the subscriber line to the outgoing trunk over the combination of paths selected. As soon as this has been done the marker is disconnected from the call and is made available for another. The steps taken by the marker are summarized on RM 015, Fig. B.

The subscriber sender, however, remains on the call long enough to direct its handling through the terminating office. The set-up in the originating office is now as shown on RM 018. The holding magnets shown (except those of the sender link) remain operated until the conclusion of the conversation. Trace path of the call on equipment diagram RM 013.

BASIC CIRCUIT OPERATION

(Terminating Calls)

Part three discussed the originating of calls in a crossbar office, the method of routing the call to an outgoing trunk being the same whether the call is to be completed in a crossbar, panel, or manual office. This part discusses the handling of the call in the terminating crossbar office, the method of operation being, in general, the same whether the call originates in a panel or a crossbar office. The handling of a call originating in a manual office differs somewhat, however, so that the completion of this type of call will also be discussed.

Crossbar to Crossbar Call

As discussed in Part 3, the calling line in the originating crossbar office is connected to an outgoing interoffice trunk to the terminating crossbar office. The subscriber sender remains on the call long enough to register the called number in the terminating sender in the terminating office.

Crossbar System - Interoffice Trunks

The interoffice trunks are outgoing from the horizontal terminals of the secondary switches on the office link frame in the originating office. In the terminating crossbar office they appear on the horizontal terminals of primary switches on an incoming link frame.

These trunks correspond to the incoming trunks of the panel system which are terminated as selectors on an incoming frame. Each trunk includes relay equipment which provides talking battery, ringing, and supervision for the called subscriber, as in the panel system. They also provide overflow (all paths busy) and busy signals for the calling subscriber, the latter feature being provided by the final selector in the panel system.

Terminating Sender - Full Selector and "B" Operator

Terminating senders are of two kinds: Full Selector and "B" Senders.

Full selector senders are employed in crossbar offices on terminating calls which originate in panel or crossbar offices. The sender handles calls from either type of office in the same manner. It does this by means of revertive pulsing, the effect on the originating sender (whether crossbar or panel) being the same as if the revertive pulses were coming from the commutators of panel incoming or final selectors. The action of the originating sender leaves the called number registered in the terminating sender. The subscriber sender in the originating office is then no longer required and is dismissed from the call.

Attaching a Terminating Sender to an Incoming Trunk

The action involved in attaching a terminating sender of either kind to an incoming trunk for the handling of an incoming call is similar to that which takes place in attaching a subscriber sender to a calling line in the originating crossbar office. A "terminating sender link frame" is provided for this purpose (see RM 013). The incoming trunks appear on the horizontals of primary switches on this frame and the terminating senders on the horizontal terminals of the secondary switches. The connections between primary and secondary switches are referred to as "terminating sender links" and the choice of an idle sender and the operation of the necessary magnets to connect it to a particular trunk by means of a link is performed by the terminating sender link control circuit (see RM 017, Fig. A). Incoming trunks requiring access to full selector senders and those requiring "B" senders may be associated with the same terminating sender link frame, the trunk indicating to the link frame which type of sender is required.

Connection to Terminating Marker

The number registered in the terminating sender is transferred to a "terminating marker" which controls the setting up of the call between the incoming trunk and the called line. The sender and terminating marker are connected together by a marker connector similar to the originating marker connector in the originating crossbar office. The terminating marker now proceeds to locate the particular called number in order to determine what combination of paths will be required in setting up the call.

Action of Terminating Marker

The terminating marker is similar to the originating marker in that it contains no switches but consists entirely of relays, terminal strips, etc. From the digits of the number registered in the terminating marker, the marker determines in which "number group" the called number is located. A number group is a group of numbers which the marker treats as a circuit unit and into which only one marker may work at a time. The terminating marker obtains access to the particular number group through a "number group connector" frame and operates a "twenty block relay" serving the twenty lines in which the called line appears. Through this relay the marker obtains access to the sleeve of the required line and also obtains information as to the line choice in which the required line is located.

All the lines in the office are divided into "choices", each choice consisting of those lines served by four line link frames. The actual number of lines in a choice varies depending upon the number of lines served by each line link frame. The "line choice connector" gives the marker momentary control over the line link frame on which the called line is located as shown on RM 017. Associated with the line choice connector is the "line junctor connector" which gives the marker access to the test leads of line junctors and permits it to operate the required selecting and holding magnets to complete the call.

Connecting to Called Line

The number group connector thru the block relay frame tests the called line for busy and if it is found idle when the busy test is made, the terminating marker proceeds to set up a connection to it. In order to accomplish this it requires the assistance of the line link control circuit as well as the other frames described above. If the control circuit happens to be busy on an originating call, the marker waits for its release after which it takes momentary possession of the line link frame to the exclusion of originating calls. In case of simultaneous attempts by several terminating and originating calls for the use of the same line link frame, terminating and originating calls will alternate until all have been served.

In order to connect the incoming trunk to the called line, a combination of three paths is required. First, there must be a line junctor to connect the incoming frame to the line link frame (incoming link secondary switch to line link secondary switch); second, there must be an incoming link to connect the incoming trunk to the line junctor (incoming link primary to incoming link secondary switch); third, there must be a line link to connect the line junctor to the called line (line link secondary to line link primary). The terminating marker obtains control over the test leads of the available incoming links through an "incoming connector" and over those of the line junctors and line links through the "line junctor connector." Since there are a number of each of these paths which may be available for a particular call, the terminating marker determines which particular combination of three that shall be used by a channel testing process similar to that described previously for the originating marker in the originating office.

As soon as an idle combination has been found, the terminating marker in conjunction with the line link control circuit, line choice connector, line junctor connector, and incoming link connector operates the necessary selecting and holding magnets to connect the incoming trunk to the called line over the combination of paths chosen and then disconnects itself. The steps taken by the marker are summarized on RM 017, Fig. B.

The incoming trunk circuit rings the called subscriber bell and supplies him with talking battery. The call in the terminating office is now complete from the incoming trunk through the incoming link and line link frames to the called line. Trace path of call on RM 012 or 013.

Manual to Crossbar Call

Calls originating in manual offices for completion in crossbar offices are handled by means of a call distributing "B" switchboard. This process is illustrated on RM 018. "B" senders are provided in which the number written up on the "B" operator's keys is recorded. These "B" senders have access to terminating markers and the call is completed by the terminating marker in a manner similar to that described for calls originating in crossbar or panel offices.

Completion of Crossbar Calls in Panel and Manual Offices

As previously stated, the routing of an originating crossbar call to an outgoing trunk is, in general, the same whether the call is to be completed in a crossbar, panel, or manual office. After the selection of the interoffice trunk, however, the call is handled in accordance with the type of terminating office. Where the crossbar call is to be completed in a panel office, the trunks terminate as incoming selectors on a panel incoming frame. The subscriber sender in the originating crossbar office directs the incoming and final selectors on a revertive pulsing basis to select the called number. The procedure in the terminating panel office is the same, therefore, as though the call had originated in another panel office.

A call originating in a crossbar office to be completed in a manual office is handled on a call indicator basis. The crossbar subscriber sender in this case transmits call indicator pulses to the "B" position in the manual office for the purpose of causing a display on the "B" operator's indicator.

CHAPTER 1

SECTION 2

CROSSBAR SYSTEM CIRCUIT FEATURES

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CROSSBAR SYSTEM CIRCUIT FEATURES

CHAIN RELAY CIRCUITS

Chain relay circuits are used extensively and are very vital to the crossbar system. Consequently a brief description of their operation is being given at the beginning of our circuit study. Some chain relay circuits are used to recognize simultaneous attempts to place calls at various points in the system. Other chain relay circuits are used to indicate idle paths and to prefer a particular one of those available. These chain circuits then determine which call shall be served first or which path shall be used. In some cases the calls that were locked out will then try to use other available circuits.

DOUBLE TRANSFER RELAY CHAIN RM 019

The double transfer relay chain circuit is used where a number of circuits have access to one circuit and may all attempt simultaneously to make connection. Practically the same type of chain circuit is used extensively in crossbar equipment. This type of chain circuit gets its name from the 1, 2, 3 bottom contacts which transfer the operating circuit of the relay to a locking circuit and from the 1, 2, 3 top contacts which transfer the functional circuit, so that the operation of only one relay in the chain is effective. If one call is originated at a time, it is handled without delay, the A lead ground advancing the circuit to perform its usual function. It should be noted that the relay to the right is the preference relay whenever there are simultaneous calls and of course the associated circuit is able to handle its call whenever it can operate its preference (MP) relay. The preference relay is determined by the relay to which the A and B grounds are directly connected.

First, assume that a call is using the right hand, first, (MP) relay. Either or both of the intermediate or last (MP) relays may operate while the first (MP) relay is in use; however, due to the opening of the A ground at contact 3T of the first (MP) relay no harm is done since the circuits can not obtain access to the frame. When the call through the first (MP) relay is completed and the relay released and assuming calls have been originated to operate both of the other (MP) relays, the second or intermediate (MP) relay will now have a ground on its A lead and may thus complete its call while the last (MP) relay is still held back due to the opening of the 3T contact of the intermediate (MP) relay. Should another call come in on the first circuit for this particular frame, it can not operate its (MP) relay since its operating circuit is open at the 3B contact of intermediate (MP) relay. Thus, it may be seen that a chain relay which has the preference can not operate as long as a relay preferred later is operated. The relays which are preferred later may operate while a relay having the preference is in use and thereby those out of preference will be served before one in preference can serve a second call. When the relay last in preference releases, and assuming a call is waiting on all others, it is the intention that all relays should operate simultaneously. This requires that the slowest operating relay will close its locking contact 2B before the operating contact 3B of the fastest relay is opened. This type of relay chain circuit in a modified form is used extensively throughout the entire crossbar system.

END RELAY CHAIN CIRCUIT RM 020

This particular circuit illustration is used for testing and to determine which line in a group of ten lines is originating a call. Let us assume that the call has originated on Line 0, operating the (L-0) relay. Ground from the (L-0) relay operates the (LT-0) relay. The (LT-0) relay operates the (RE) relay, and the (RE) relay in turn operates the (LS) relay which provides a locking ground for the (LT-) relay and operates the (LE) relay. The (LE) relay in operating opens the operating circuit to all (LT-) relays. Consequently, the subsequent operation of other (L-) relays can not in any way interfere with the functioning of the circuit as long as the (LE) relay is operated. Should two other calls be originated while the one call is being served then as the (LS) and (LE) relays release from this call, the two (LT-) relays should operate simultaneously. One (LT-) relay must be fast and the other slow; however, in this case both (LT-) relays should operate, especially since considerable time is allowed for the slow (LT-) relays to operate. The fast (LT) relay must operate in turn operating the (RE), (LS) and (LE) relays, before the operating circuit is opened to the slow (LT-) relay. Assume the (LT-4) and (LT-9) relays are operated and the (RE), (LS) and (LE) relays operate. In this case, only the (LT-4) relay locks and the (LT-9) relay releases. In this case the (LT-4) relay is the preferred relay as determined by the locking transfer contacts of the chain relays. Only one of the chain relays is operated during the remainder of the time the call is being established.

Numerous other applications of the end relay chain circuit are used in the crossbar system and should be recognized as such whenever encountered.

CHANNEL TEST CIRCUIT RM 021

The circuit used for testing for an idle channel between a district junctor, used in originating a call, and a desired outgoing trunk is shown on RM 021. In this circuit the originating marker has seized the office link frame, has tested and found an idle outgoing trunk, and has operated the link connector (LC) relay associated with the selected trunk. This connects through the link sleeve LS leads of twenty office links to the marker for test, one from the left half of each primary switch, and one from the right half of each primary switch.

The marker has also seized the district link frame associated with the district junctor and through the originating sender has connected the district junctor to the district link and operated its associated link connector (LC) relay. In a manner similar to the (LC) relay of the office link, this (LC) relay closes through the link sleeve LS leads of the twenty district links which may serve the district junctor calling.

The marker has also operated the junctor connector (JC) relay associated with the office junctors connecting the district and office link frames involved in this call. This connects through the sleeves of the office junctors to the marker for test. Each (JC) relay closes through the sleeve S leads of a maximum of twenty office junctors, one from the left half and one from the right half of each district link secondary switch to the associated left and right halves of office link primary switches if there are ten district link frames and office line frames.

A channel is a path between the selected trunk and the district junctor. If the office secondary multiple is split, then there is a maximum of ten channels from each trunk to any district. If the trunk is on the left half of the switch, the ten channels will go through the left halves of the four switches, district link primary and secondary and office link primary and secondary switch. There will be one channel through each of the district link secondary and office link primary switches. If the trunk is on the right half of the office link secondary switch, then the channels use the right halves of the four switches. If the office link secondary switch multiple is not split, then the links on both the right and left halves of switch are available; consequently, there are twenty channels available to establish a connection between the trunk and district junctor.

The three test leads LS, S, and LS of each channel are connected to a pair of (AB) and (C) relays. The three paths which form a channel are referred to as A, B, and C links. A refers to the district link, B to the office junctor and C to the office link. The (AB) and (C) relays can be considered as a single relay with a single transfer contact which is used in a chain circuit with other similar relays. If any one of the links in the channel is busy, the (AB), or (C) relay operates the channel can not be used for this call. Under this condition, the chain circuit advances the preference on to the next relay in the line of preference. If the three links in the channel are all idle, then the channel may be used and the associated channel (CH-) relay is operated.

The (CH-) relay operated closes the three test leads through to another portion of the marker to be used later in operating the four hold magnets in the channel to establish the connection.

It should also be noted that the (C) relay has two windings. One winding is connected to the C office link while the second winding is used for "blanking" out a channel in a pattern arrangement by operating a pattern relay or, in case the multiple of the office secondary is split, one half of the twenty channels to the office secondary switch must appear busy by being blanked out. This is accomplished by the use of the split left (SPL) or split right (SPR) relay.

CONDENSER TIMING RM 022

Condenser timed polarized relays are used extensively in the crossbar system. Consequently a brief description of their operation is being given at the beginning of our circuit study.

RM 022 shows a condenser timed polarized relay and its operation. It is used primarily to delay its operation until other functions have been performed by the circuit in which it is used.

Before considering the operation of this circuit, these three facts must be observed:

(a) That the secondary winding of the polarized (C) relay is wound in the opposite direction to that of the primary winding.

(b) That the secondary winding of the polarized (C) relay has a stronger magnetic field than the primary, because there are more turns of wire.

(c) That the (P) condenser connected to polarized (C) relay secondary winding has a very large M.F. capacity, 8 to 30 M.F. (compare this to the average one-half microfarad capacity condenser used for contact protection in telephone circuits).

The operation of (A) relay connects battery to both primary and secondary windings of (C) relay, and also grounds primary side of (C) relay, and the (P) condenser. The direct ground from normal (B) relay will now discharge (P) condenser. Both windings of the (C) relay are now energized, but they are opposing each other. The secondary winding being the stronger causes (C) relay armature to be driven to its back contact.

Operation of (B) relay disconnects the direct ground from secondary winding of (C) relay; however, armature does not move from back contact because secondary, the stronger winding, is still being energized by current flow into the large (P) condenser. As the (P) condenser is charging up, the current flow in (C) relay secondary winding is decreasing, thereby decreasing the magnetism in the secondary winding, till finally the primary is the stronger winding which moves armature to the front contact. When the (P) condenser is fully charged, no current flows in the secondary winding of the polarized (C) relay.

DIALING CIRCUIT RM 023

The correct counting and recording in the central office of a train of dial pulses depends largely on the action of the pulsing relay. This relay responds to the momentary openings and closures of the subscriber loop caused by the dial as it returns to normal, and gives out corresponding openings and closures of the subscriber loop caused by the dial as it returns to normal, and gives out corresponding openings and closures of its contacts to the circuit or mechanism that counts and records these pulses. In addition to variations in the time intervals of the dial pulses, there are a number of electrical effects imposed on the pulsing relay which may interfere with its correct operation. Some of these tend to hold the relay when it should release; long loops reduce the current needed for operating the relay when it is supposed to operate; and other effects tend to cause the relay to operate or release falsely. The degree of fidelity with which the relay follows legitimate dial pulses, and the margin by which it withstands various impulses to operate or release falsely, are measures of its efficiency. In these respects the relay developed for the subscriber sender of the new crossbar dial system, and recently adapted to the more widely used of the panel system senders, represents important improvements as compared to relays previously used for this service. Outstanding among these improvements are an extended loop range and a greater permissible variation in the speed of operation of the dial.

The new relay will respond satisfactorily to either ten or twenty pulses per second over 1500-ohm loops, while the former relay would respond to ten pulses per second only over loops not exceeding 1000 ohms, and to twenty pulses per second only over loops not exceeding 350 ohms. Strictly speaking, however, the new development should not be referred to as a relay but rather as a pulsing or dialing circuit, since the circuit features immediately associated with the relay account for its efficient operation certainly as much as do the characteristics of the relay structure itself.

A different relay is employed as well as a new circuit, however. Former pulsing circuits have employed an L-type relay, while for the new circuit, a 239-type relay is employed. The structure of this latter relay is of low inductance, and is thus conducive to fast response. In addition, by using a biasing winding, it lends itself better to the securing of a high "percentage release," which expresses the relationship between the release and operate currents of a relay. The higher this ratio the larger the variations in operate and release conditions the relay can tolerate. The reasons for this are indicated in Fig. A, which shows the current conditions existing during two extreme pulsing conditions. The upper graph of this figure represents the worst conditions for the release of the pulse relay on a short subscriber's line, i.e., maximum ringing bridge capacity and maximum leak. The lower graph represents the worst conditions for the operation of the relay on a long PBX trunk with which is associated a high-speed operator's-type dial. With operate and release currents such as those of the older L-type relay, as represented by the lines a-a and b-b respectively, the percentage release is comparatively low and consequently the interval of time during which the relay may be in the released position under the first set of extremes or in the operated position under the second set of extremes is short in either case. These intervals are indicated by the distance on the time scale between points R and O. With operate and release currents as represented by c-c and d-d, however, which apply to the new 239-type relay and illustrate a high-percentage release, the releasing and operating intervals are considerably longer as indicated by the points R' and O'.

The arrangement of the new pulsing circuit as it appears in the crossbar sender, together with the elements of the subscriber telephone set involved in dialing, are shown in Fig. B. The pulsing relay is of the polarized type, and employs no retractile spring against which the operate winding must act. Release is secured by a separate biasing winding. The current through this winding is adjusted so that at nominal voltage and with 18.5 milliamperes in the operate winding, there will be zero flux in the core -- and thus no tendency for the armature to move in either direction. When the relay is properly adjusted, it will then operate on 20 milliamperes and release on 17, a change of only 1.5 milliamperes on each side of the zero-flux current. These values of current will vary with the battery voltage, but since both windings are supplied by the same battery, there is a natural compensation. As the current in the operate winding rises or falls with changes in voltage, the current in the compensating winding will also rise or fall, so that their differential effect tends to remain constant.

With this sensitivity, and the high-percentage release, the pulsing relay has ample margin for releasing and operating in response to regular dial openings and closures. Under some conditions, however, transients occur that might cause false operation or release if additional precautions were not taken. In the dialing circuits of PBX boards and order turrets, for example, the loop is held closed through a retard coil of moderately high inductance. When the dial is operated, this coil is short-circuited, but shortly after the dial returns to normal, the retard coil is reinserted in the loop. This causes a sudden lowering of the line current, momentarily dropping it to a point appreciably below the steady-state value, and thus tending to cause the release of the pulsing relay.

To counteract this tendency, the condenser and resistance marked R in Fig. B are connected between the line side of the operate winding and ground. When the retard coil is connected back into the circuit, the voltage across the line, and thus across the condenser, rises, and a momentary charging current flows through the relay winding to the condenser. This current is sufficient to counteract the decrease in line current, and thus holds the relay operated. The action is indicated in RM 024. Without the condenser, the current would follow the dotted curve when the retard coil was reinserted, dipping below the release value. With the condenser in the circuit, however, the current follows the solid curve, and remains well above the release value. There is a similar charging current to the condenser tending to hold the relay operated when the pulsing contacts of the dial open and the relay is supposed to release. In this case, however, the effect is spent in the early part of the pulse and is therefore negligible.

Difficulties may also occur because of the condensers in series with the ringers, which are permanently connected across the line. Closure of the dial contact provides a discharge path for these condensers, and when the contact opens, the condensers will recharge. Because of the high inductance of the ringer circuit, the charging current increases slowly at first, and then reaches a peak about twelve or fifteen milliseconds after the dial contact has opened. Under certain intermediate line conditions, which -- except for this -- would cause no dialing difficulties, the pulsing relay may release within the first twelve milliseconds, and then be reoperated by the charging surge, and released again with its cessation, thus causing a false pulse. RM 024 illustrates the characteristics of such a transient.

To make the new circuit completely insensitive to this form of transient, a circuit arrangement is provided that electrically locks the relay in the released position for a short period of time. If the relay does release before this charging surge it will be held released until the surge has passed.

This locking action is secured by a secondary winding connected through the PH condenser as shown in Fig. B. With the pulsing relay in the released position, this condenser is discharged because of the presence of the same battery potential on both sides of it. When the pulsing relay operates, however, it grounds one side of the condenser through the low-resistance LI relay, and so the condenser charges. The time for the charge and discharge of the condenser is determined by the constants of this secondary winding circuit, and is adjusted to secure the desired time interval. The charging current is in a direction tending to operate the relay, and the discharging current in a direction to release it. When the relay releases on the opening of the dial contact, therefore, the discharge current that flows holds it released until the charging surge of the ringer condensers has passed.

This secondary winding is also useful on long loops with short dial closures, such as occur with the operator's dial giving twenty pulses per second. The long loop tends to shorten the length of the operating pulse, but the charging current to the PH condenser when the pulsing relay operates increases the operated period and insures a closure of satisfactory length. This winding thus tends to equalize the difference between long and short pulses, since it lengthens the short pulses and has no effect on the long ones because the charging surge has died out before the dial contact has opened.

The slow-release relay SR operates when the hand set is lifted and should not release unless the call is deliberately abandoned. It is given a slow-release characteristic so that it will not release on the dial openings. Its proper action is considerably helped by placing the relay in the circuit of the secondary winding of the pulsing relay. In this position, its winding receives not only the full dial closure pulse, but the discharging surge of the PH condenser when the pulsing relay opens its front contact.

Besides the increased range and ample operating margins of this new dialing circuit, special contact wear and adjustment stability tests indicate that it will require less maintenance than the previous circuits.

REVERTIVE PULSING CIRCUIT RM 025

The revertive pulsing circuit is designed for counting electrically between two distant points and is used on a crossbar to crossbar call. By means of this circuit, the numerical digits for the called number are transmitted from the originating central office to the terminating central office. This is performed over a two wire metallic circuit, which is known as the FT and FR leads (fundamental tip and fundamental ring). The counting is done with counting relays at the originating central office which has the control. The counting is done at the terminating office with pulse relays.

Counting relays work in pairs, the one relay known as the counting relay and the other the prime relay. They are operated by pulsing grounds. One ground pulse by its closure and open, operates one pair of counting relays. Associated with the counting relays are circles with numbers. Also, associated with the control points for counting relays are like circles and numbers. It must be assumed that between the counting relays and the control points that circles numbered alike are electrically connected. This plan is used for the purpose of reducing the number of connections in the schematic drawing.

When the originating office and the terminating office are ready to make the first selection (incoming brush selection) the fundamental circuit will be closed between the originating sender and the terminating sender.

COMMUTATOR PULSING RM 026

The commutator pulsing circuit is designed for counting electrically between two distant points and is used on a crossbar to panel call. By means of this circuit, the numerical digits for the called number in the originating central office are used to control mechanical selections at the terminating panel central office.

Counting relays are used in the same manner as in revertive pulsing, but instead of two STP relays, one at each central office counting on a revertive basis, only one STP relay is used in the originating central office. This arrangement includes the L relay of a selector circuit at the terminating panel office in series with the STP relay in the originating crossbar office and control, respectively, the selector up-drive and the counting relays. As described in detail below, the up-drive stops when the L relay is released by opening of the fundamental circuit in the originating office. In order to stop the selector rod at the particular point, commutator ground pulses are impressed on the fundamental circuit during up-drive. These pulses are counted by the originating office by the counting relays, which operate in succession as the pulses are received and record the distance traveled by the selector rod.

CONTACT PROTECTION RM 027

Relay contact alloy on the majority of relays in a crossbar office is known as precious metal contacts. The contact material used must be practically free from corrosion, as corrosion acts like a high resistance film on the contact surfaces. Contacts must also be able to withstand the electrical wear caused by arcing and must be sufficiently hard to limit the wearing away to a minimum.

In order to prolong the life of contacts, contact protection circuits are used in a number of instances. They are for the purpose of limiting the arcing at the contacts and consist of a condenser in series with a non-inductive resistance to ground. When contact protection is used, the protection circuit is connected to the contact having the negative potential.

Contact protection is indicated in the circuit drawings in two ways. The original crossbar circuit drawings show the condenser and resistance to ground with all the necessary designations. The newest crossbar circuit drawings show a rectangle with ground connected, the rectangle representing the resistance and condenser. Within the rectangle is "CP" and stands for "contact protection." Adjacent to the contact protection is a designation which refers to a chart within the circuit drawing, listing the capacity of the condenser and the value of the resistance.

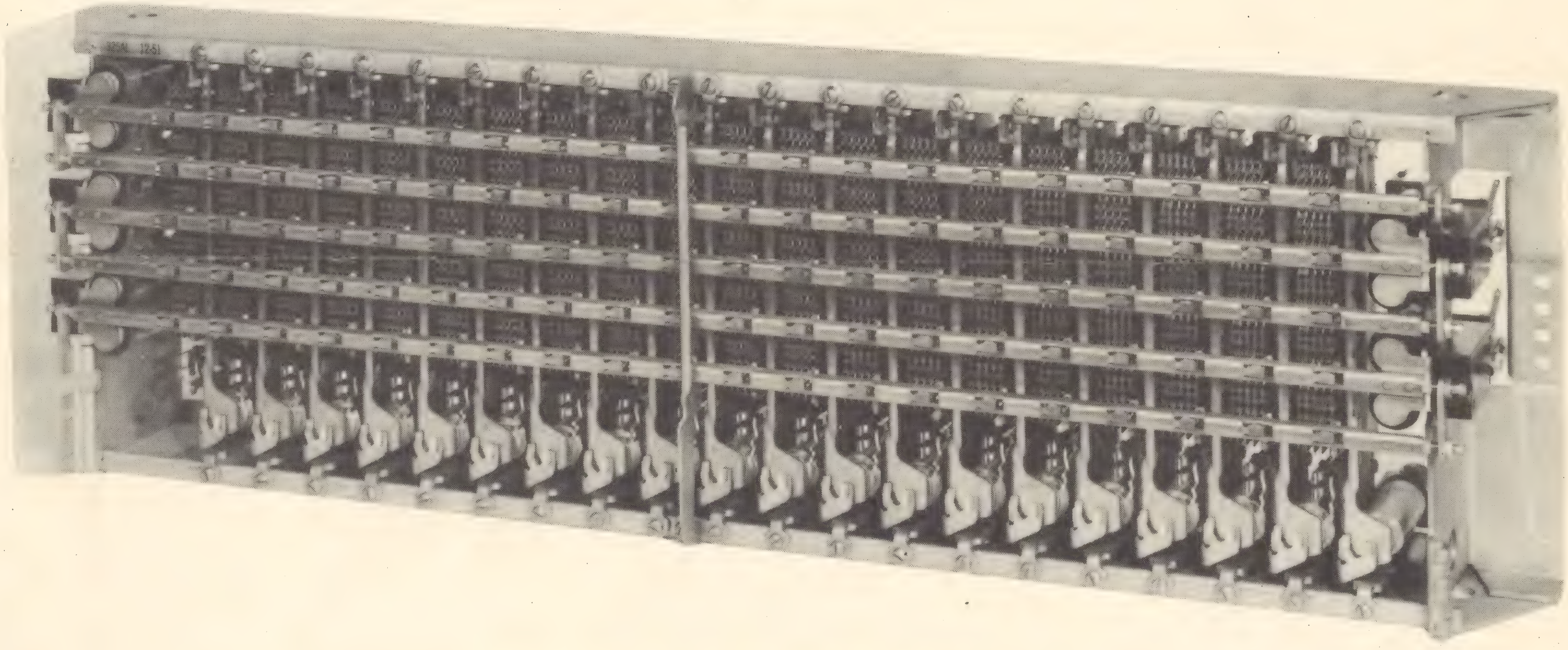
In addition to the above the newest circuit drawings have another designation for indicating contact protection associated with relay windings. This consists of a short line, crossing one end of a winding within the core and denotes that in the actual wiring of the circuit there is connected across this winding contact protection. This indicates a standard network in all cases, consisting of an 0.1 M.F. condenser and a 500 ohm resistance connected across the particular winding.

CHAPTER 1

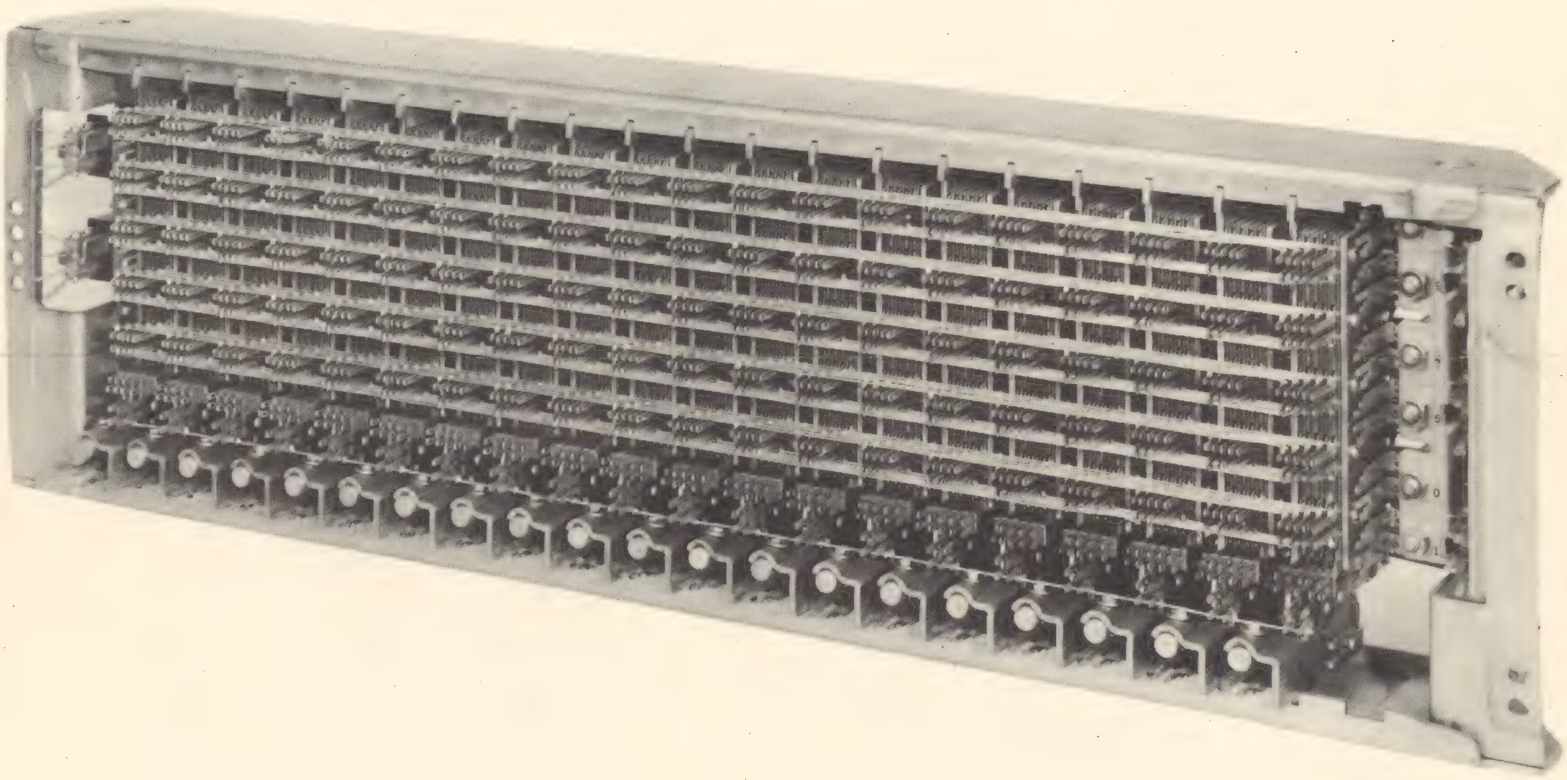
SECTION 3

NO. 1 CROSSBAR OFFICE PHOTOGRAPHS

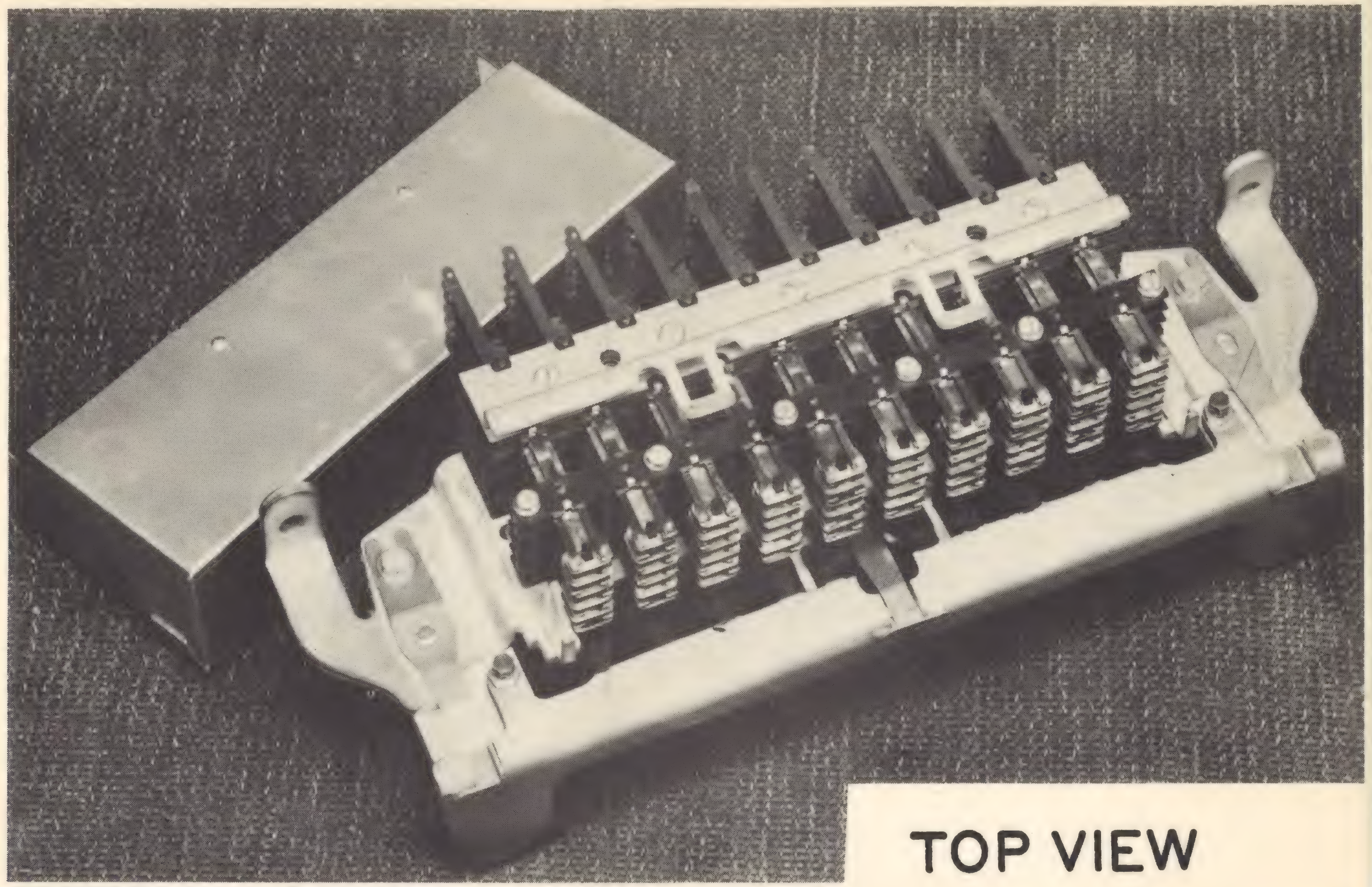
MARCH 1954



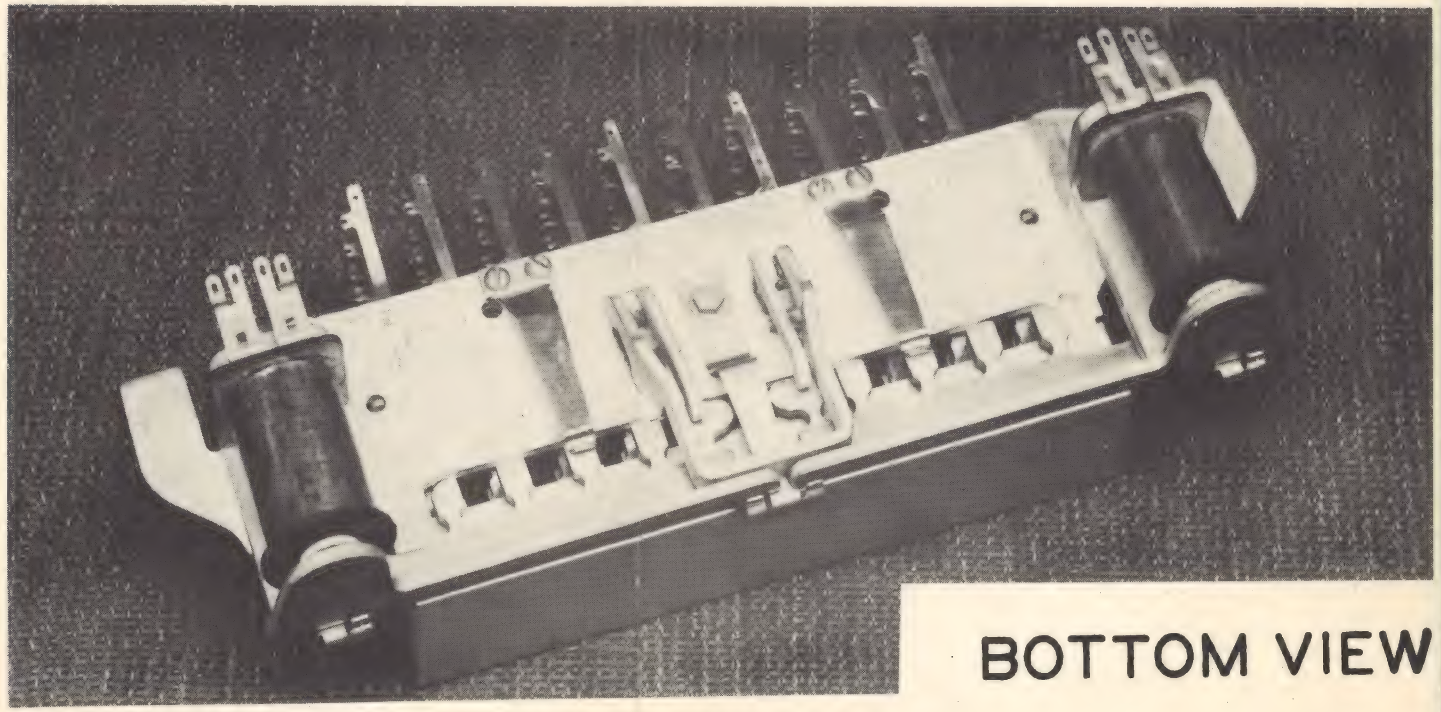
200 POINT CROSSBAR SWITCH
FRONT VIEW



200 POINT CROSSBAR SWITCH
REAR VIEW

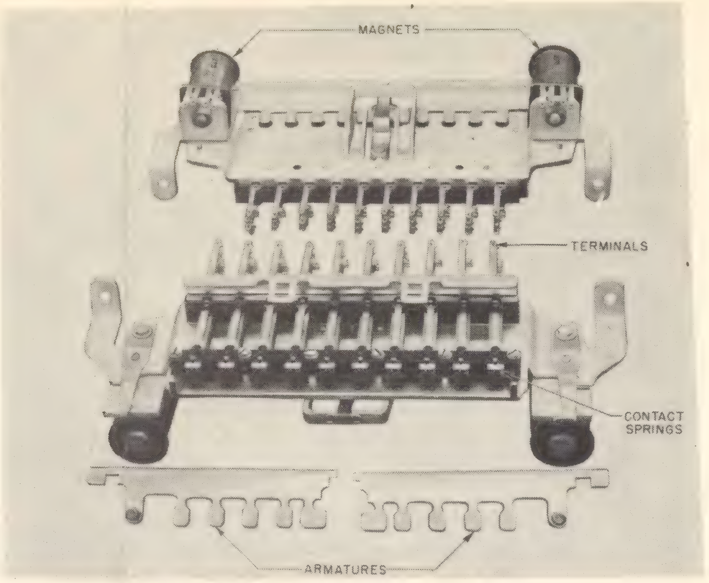


TOP VIEW

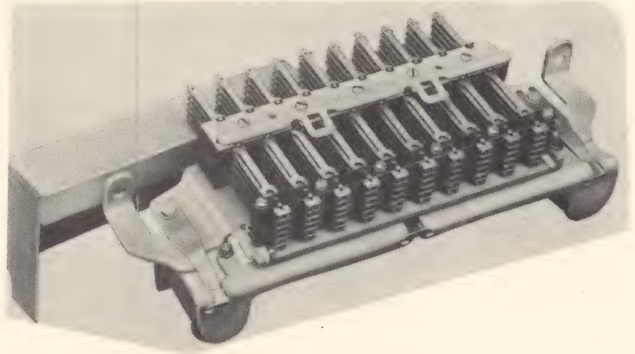


BOTTOM VIEW

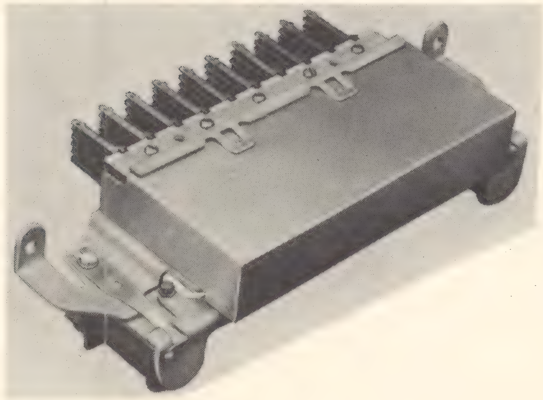
MULTI-CONTACT RELAY CARD OPERATED



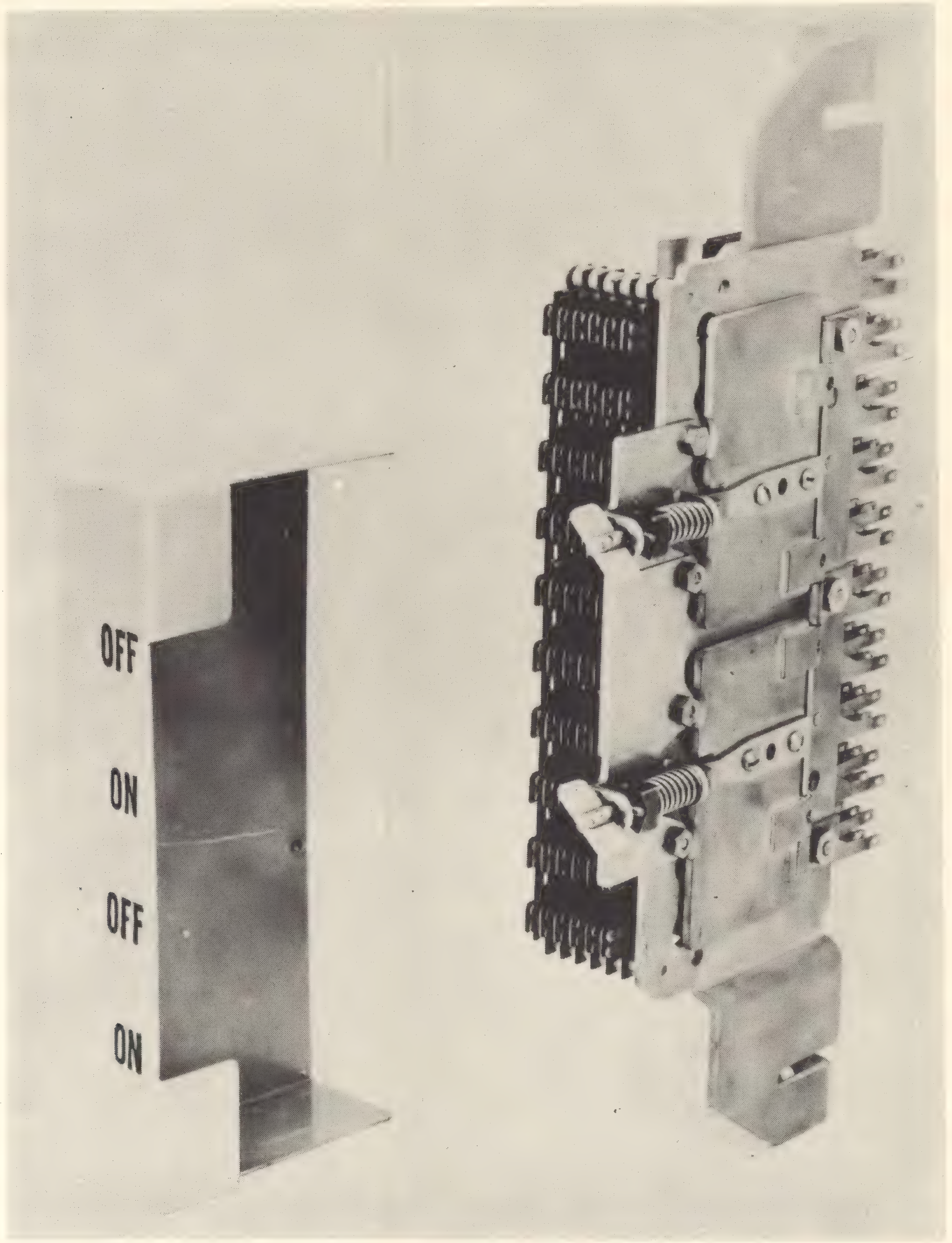
DETAILED VIEW OF RELAY



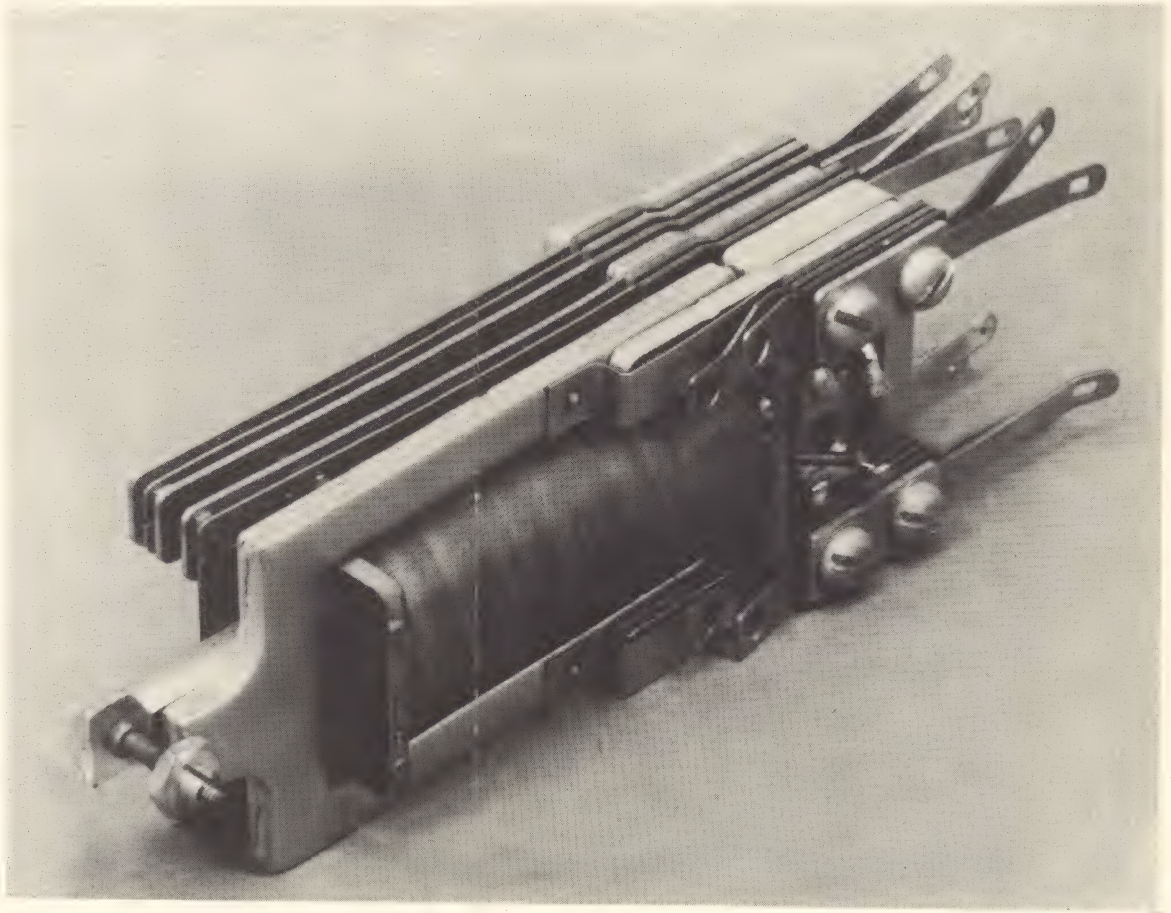
WITH COVER REMOVED



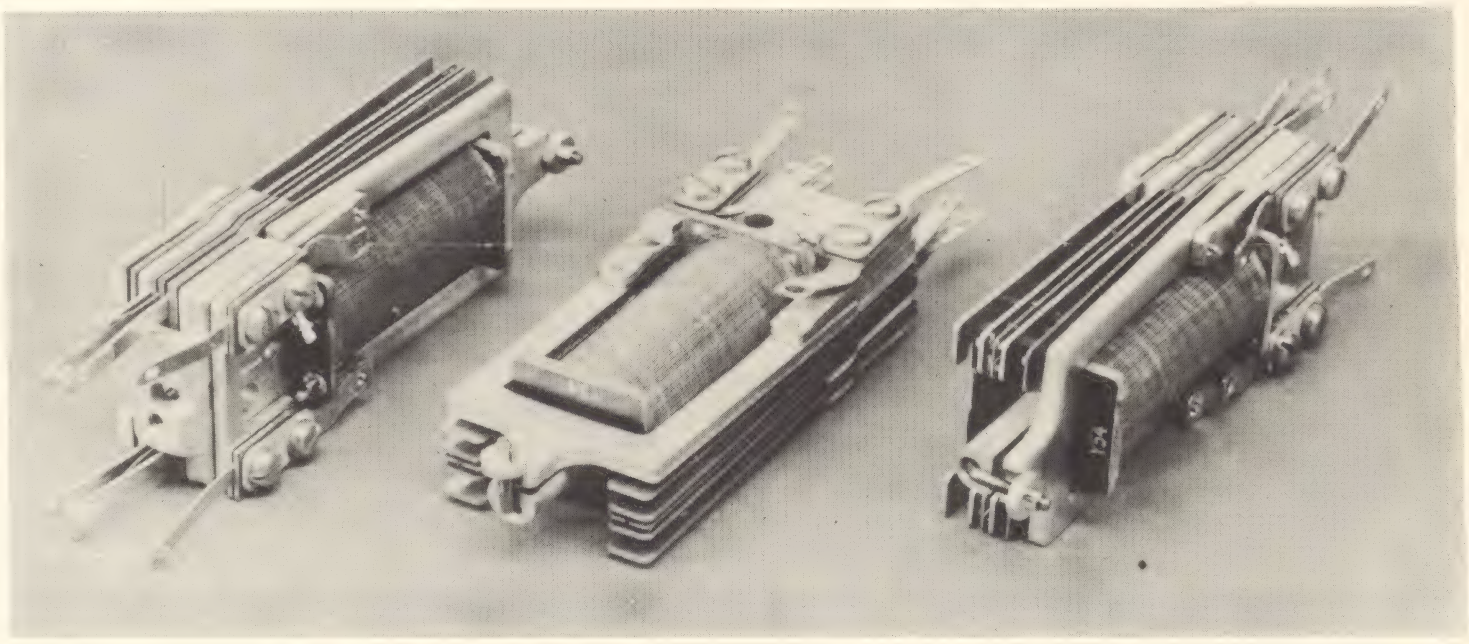
WITH COVER IN PLACE



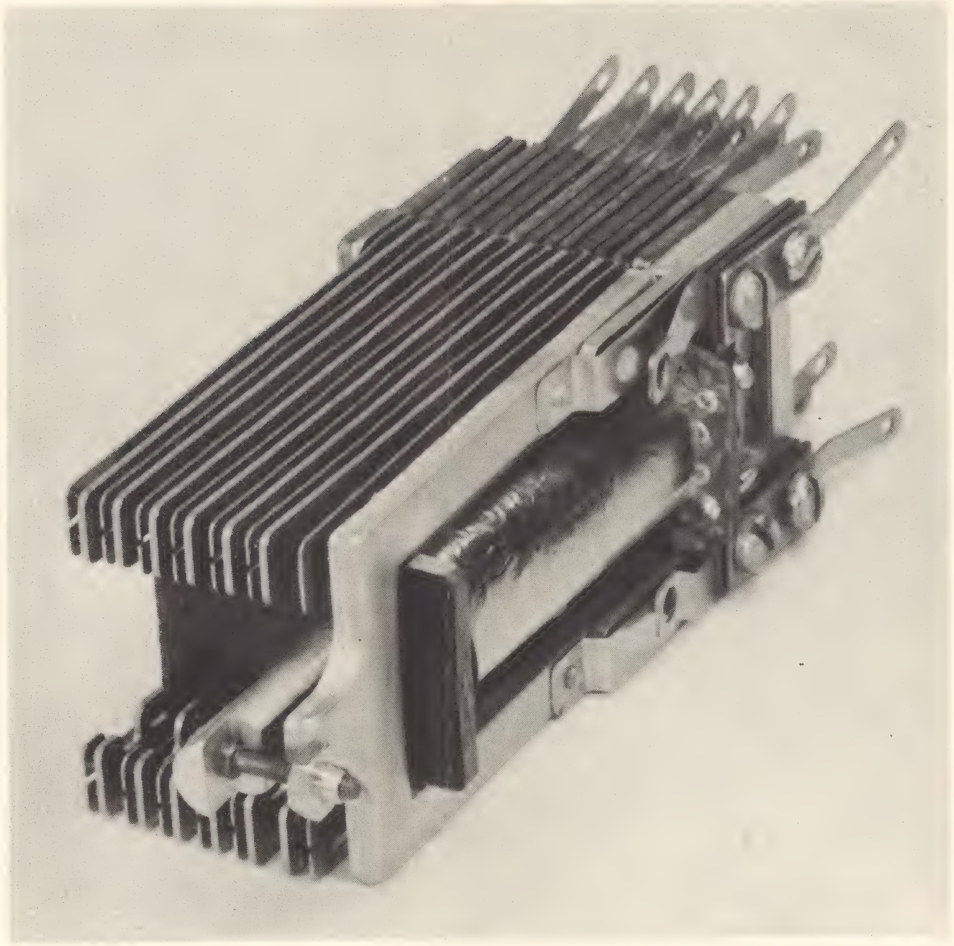
MULTICONTACT SWITCH



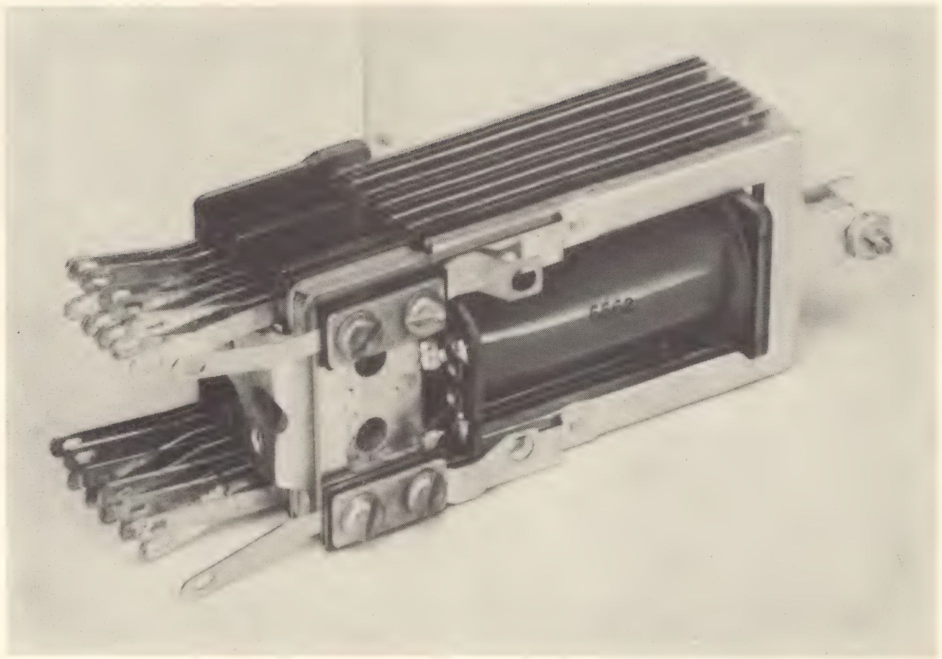
"Y" TYPE RELAY



"Y" TYPE RELAYS



"U" TYPE RELAY



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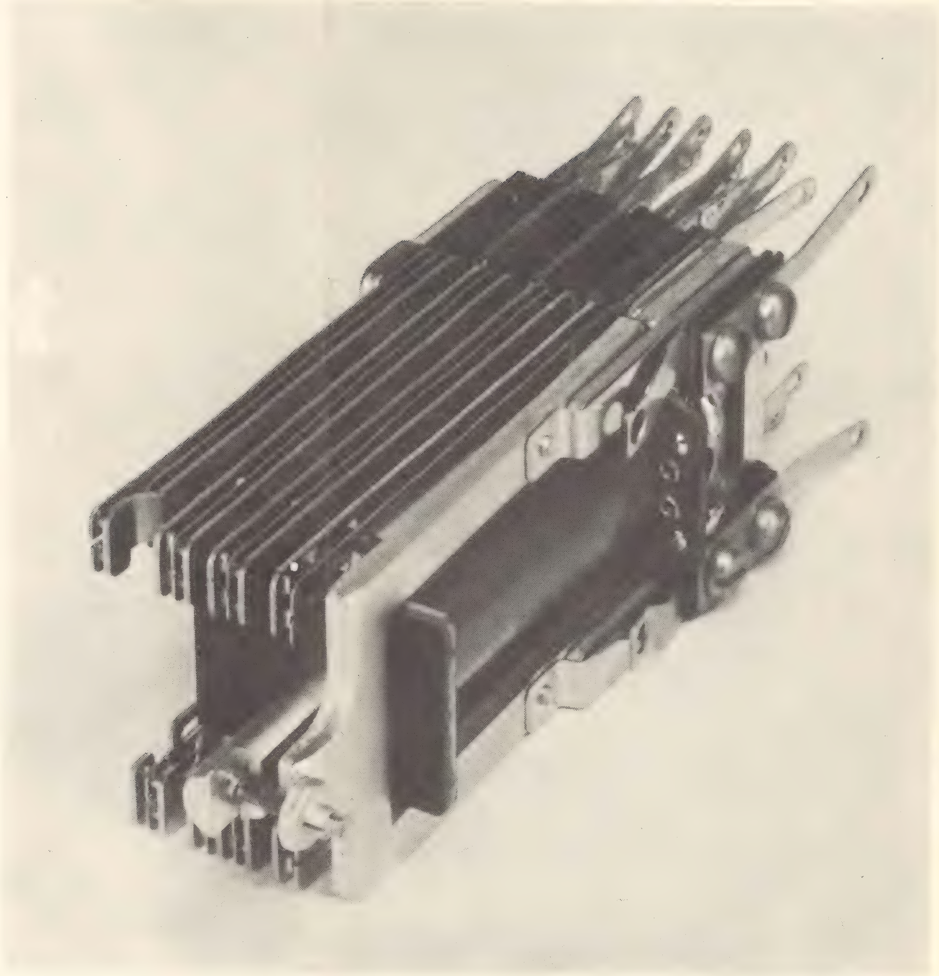
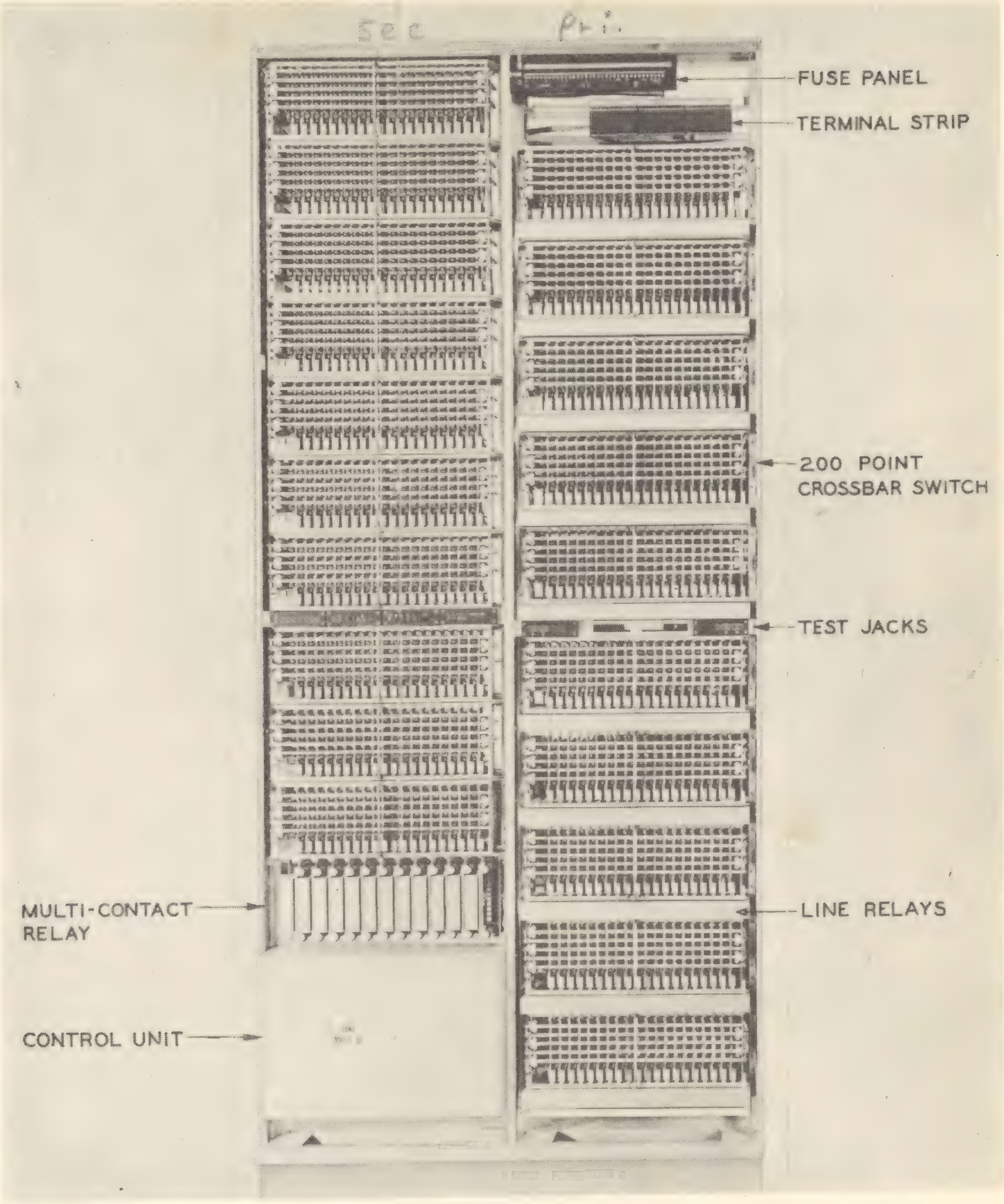
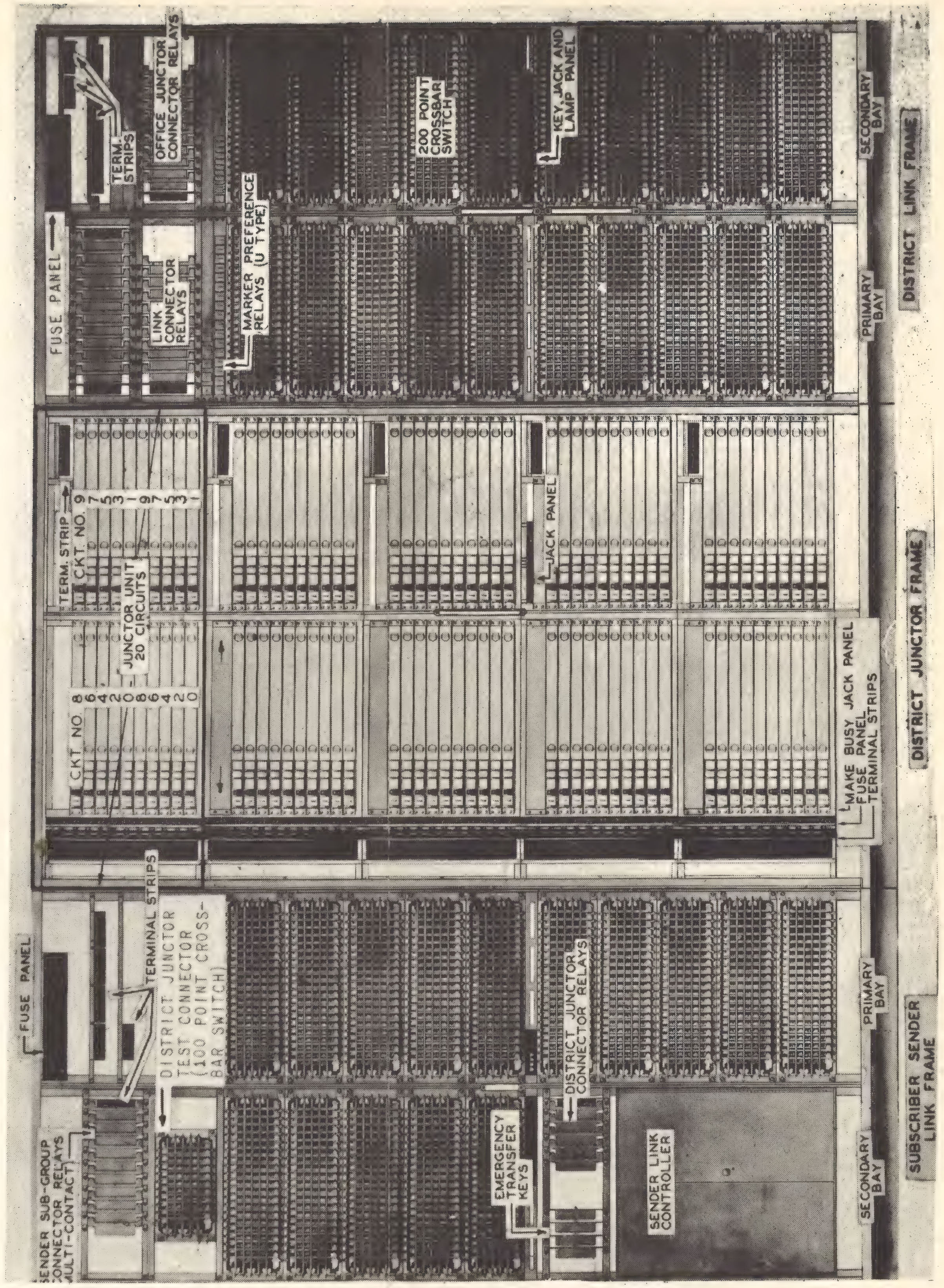


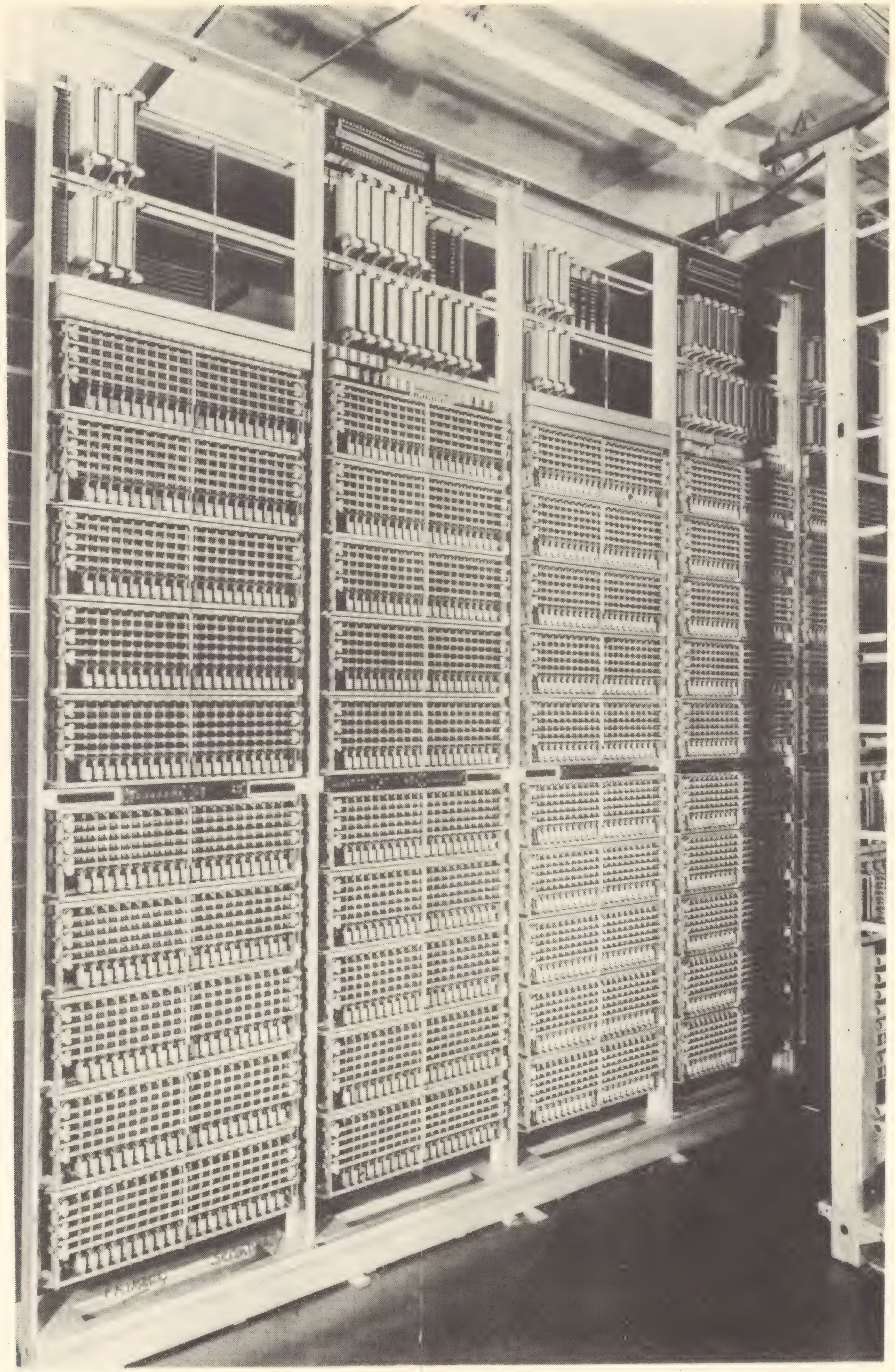
"U" TYPE RELAY



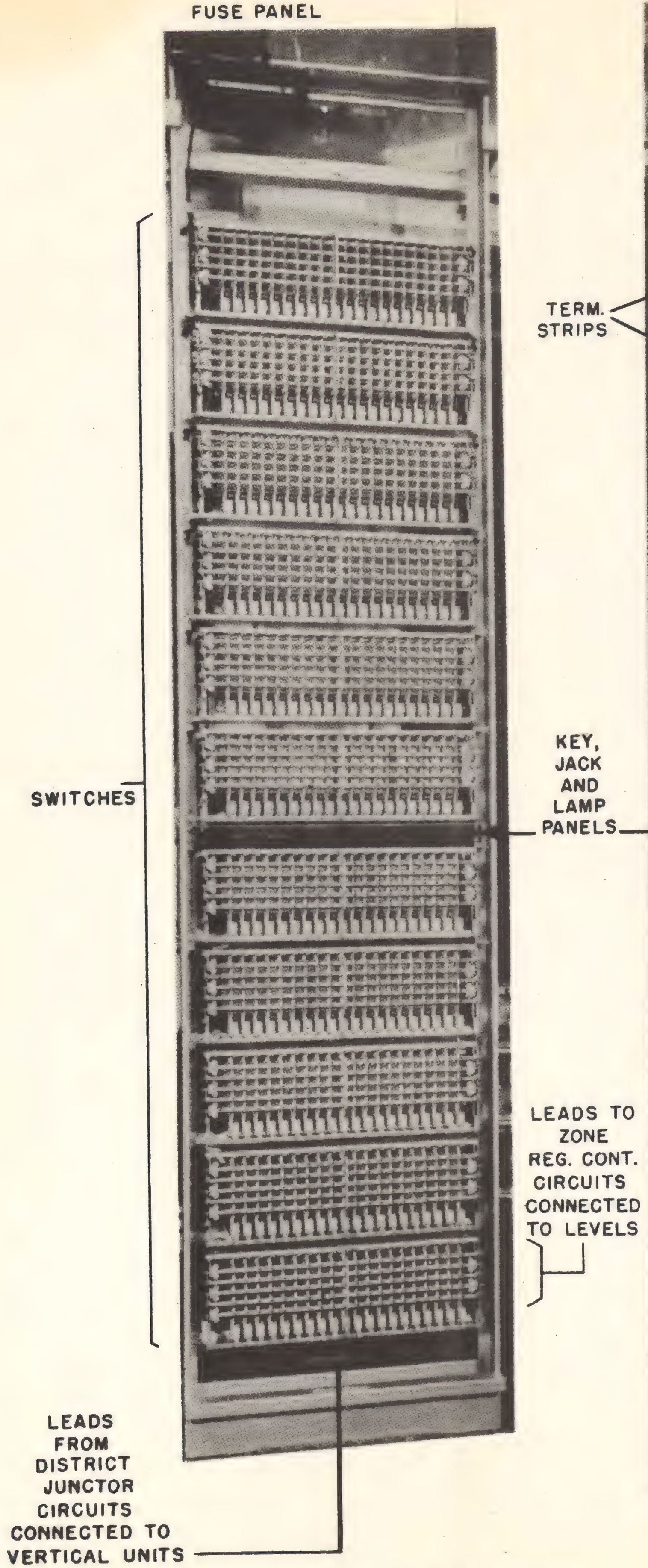
TYPICAL LINE LINK FRAME



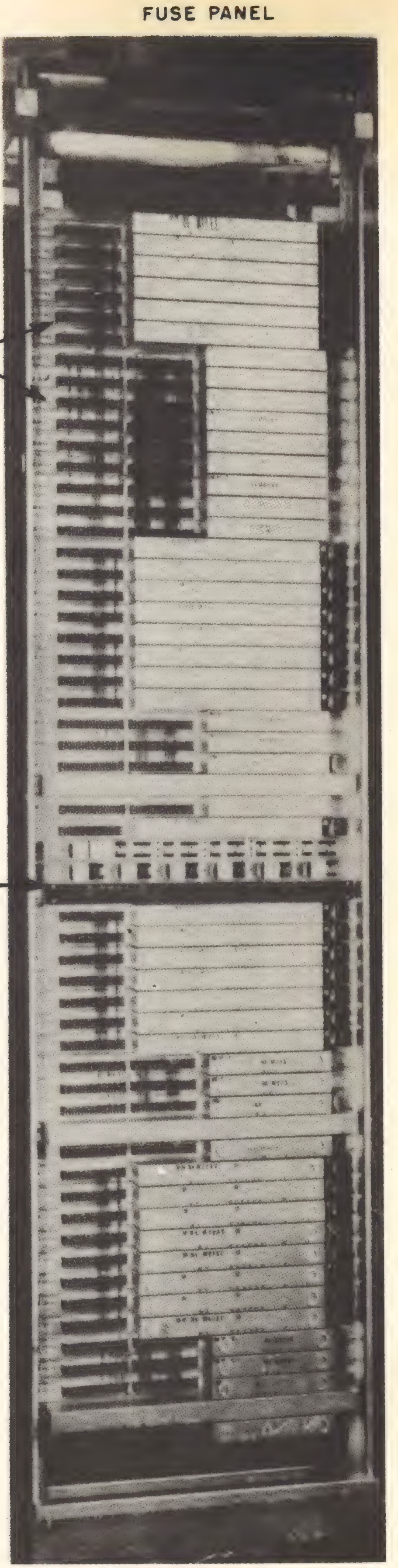
DISTRICT FRAME GROUP



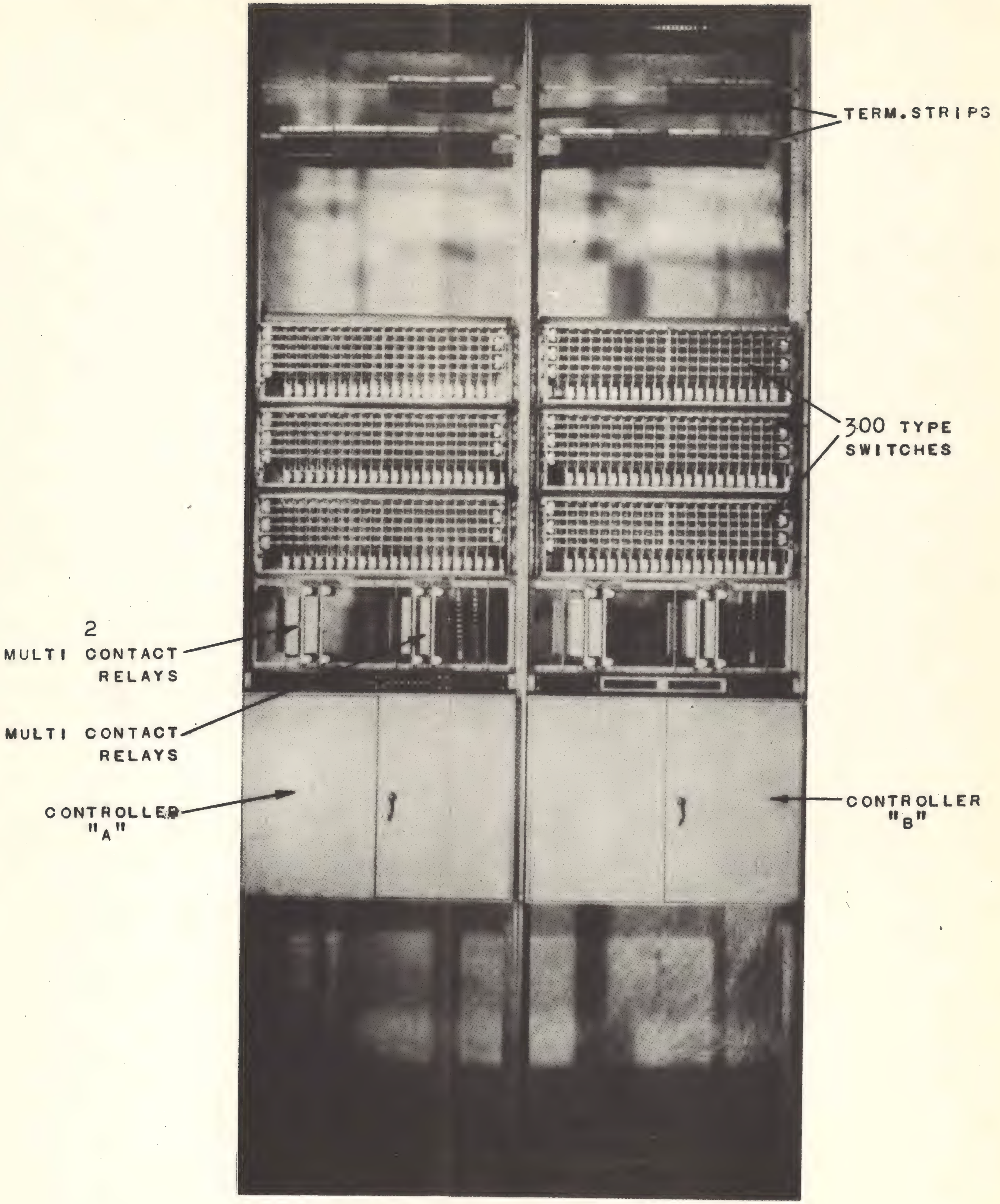
OFFICE LINK FRAME


FUSE PANEL
SWITCHES
KEY, JACK AND LAMP PANELS
LEADS TO ZONE REG. CONT. CIRCUITS CONNECTED TO LEVELS
LEADS FROM DISTRICT JUNCTOR CIRCUITS CONNECTED TO VERTICAL UNITS

ZONE REGISTRATION DISTRICT CONNECTOR FRAME

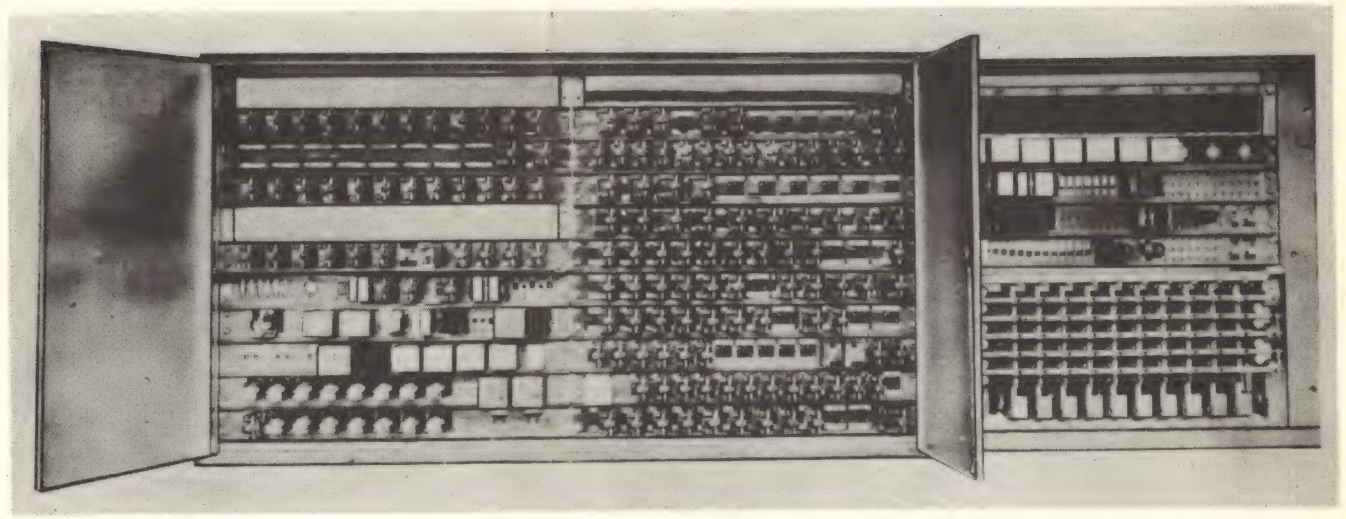


ZONE REGISTRATION CONTROL FRAME

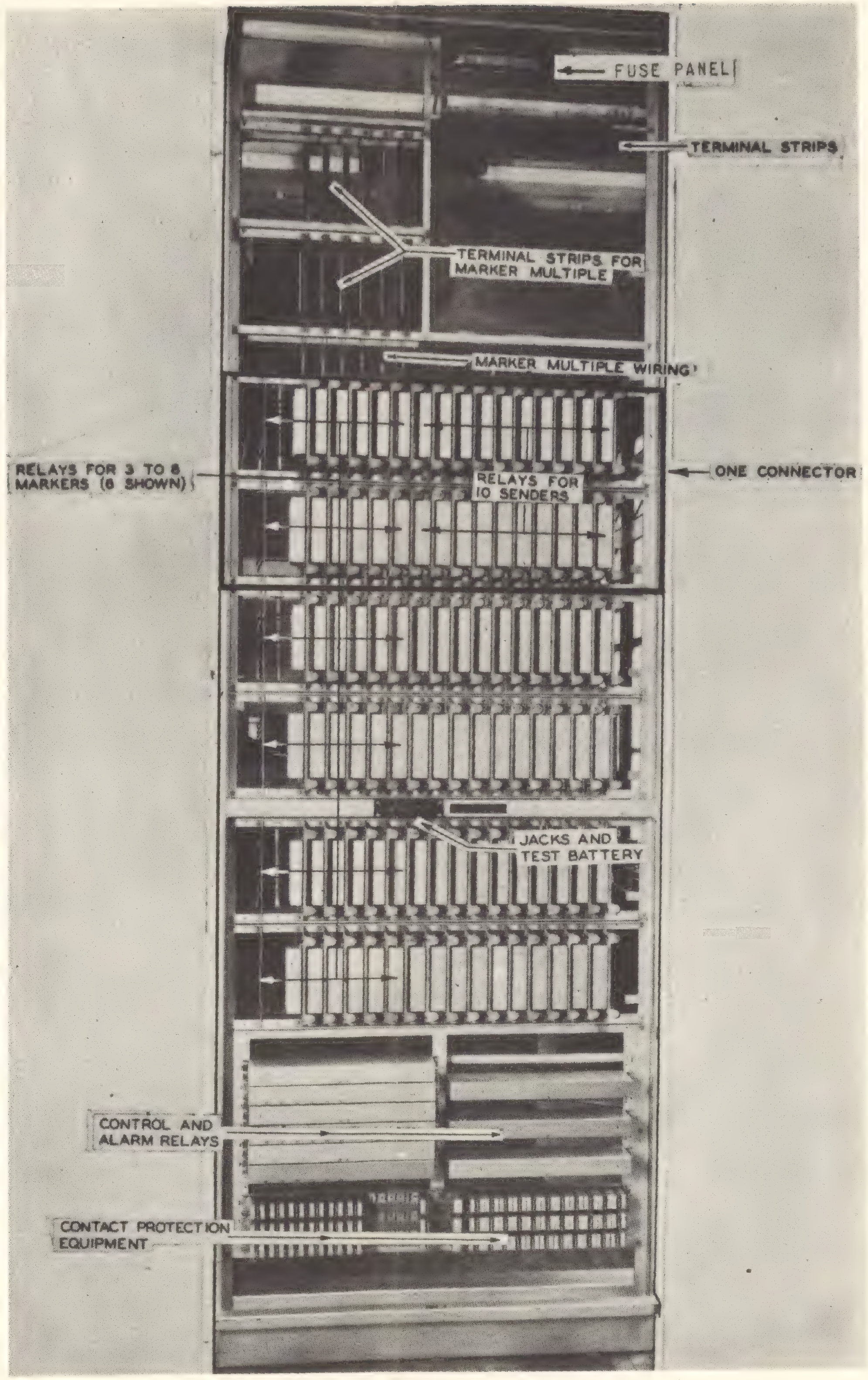


COIN SUPERVISORY LINK
KEY PULSING SENDER LINK

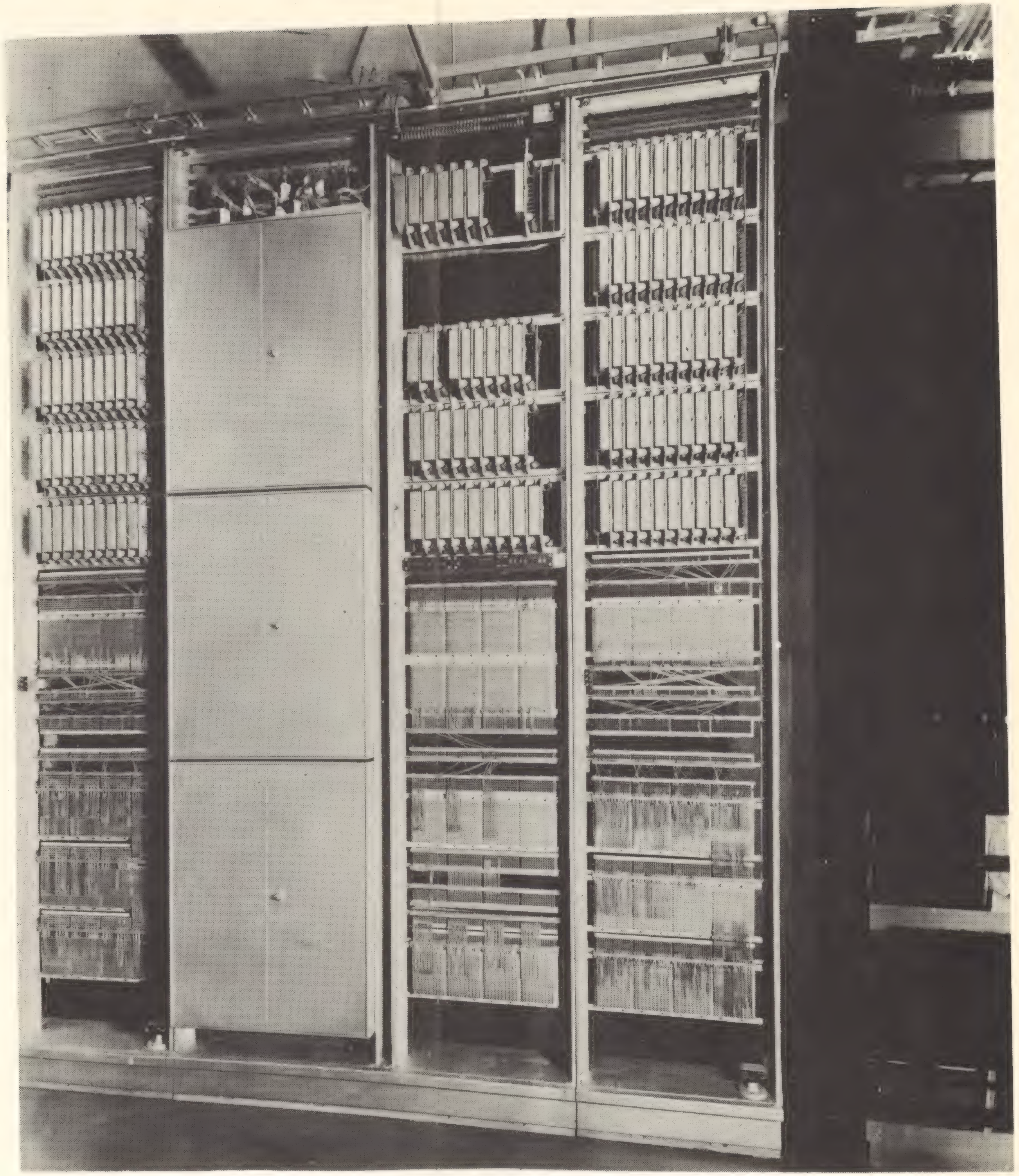
SUBSCRIBER SENDER FRAMES



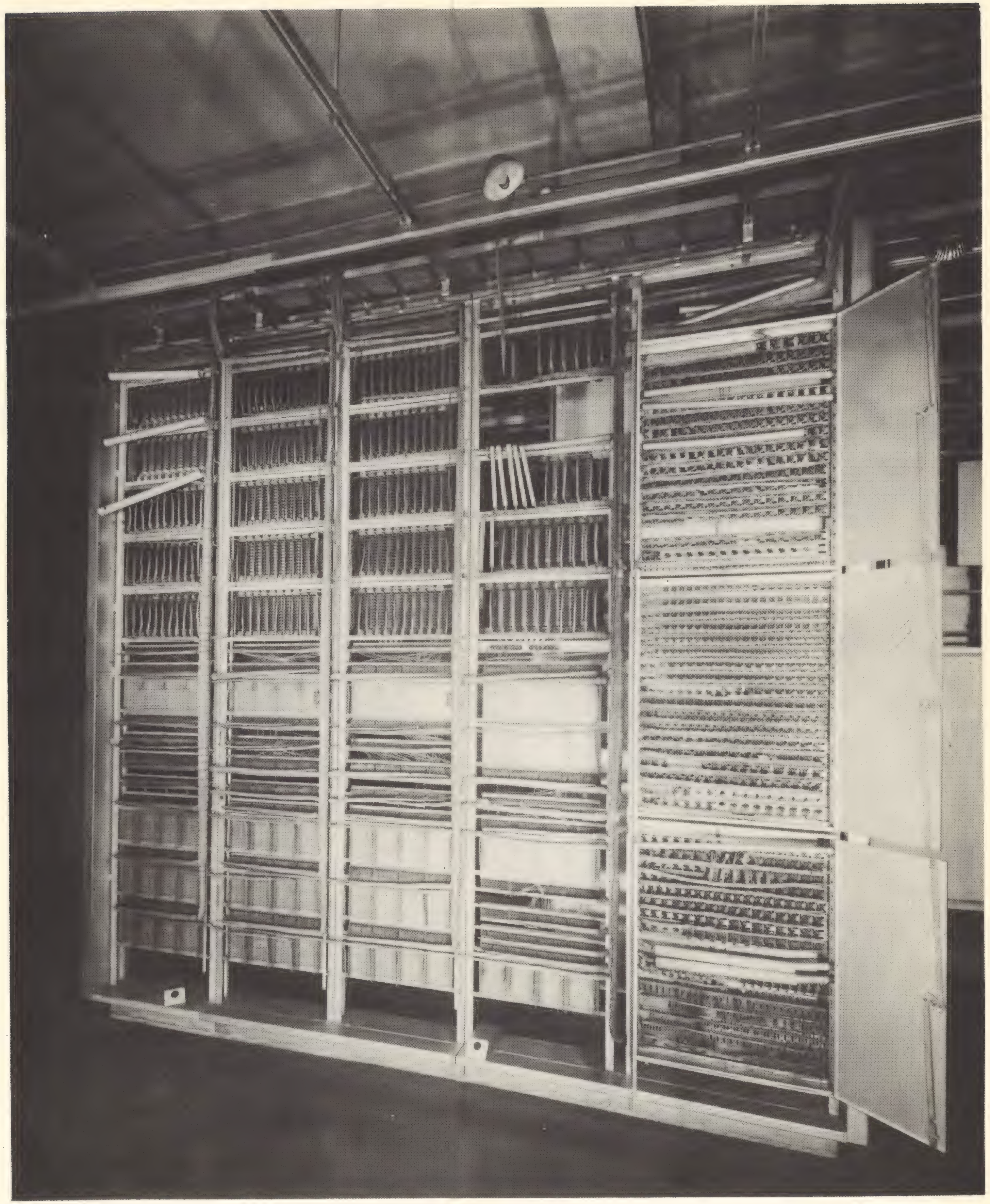
SUBSCRIBER SENDER



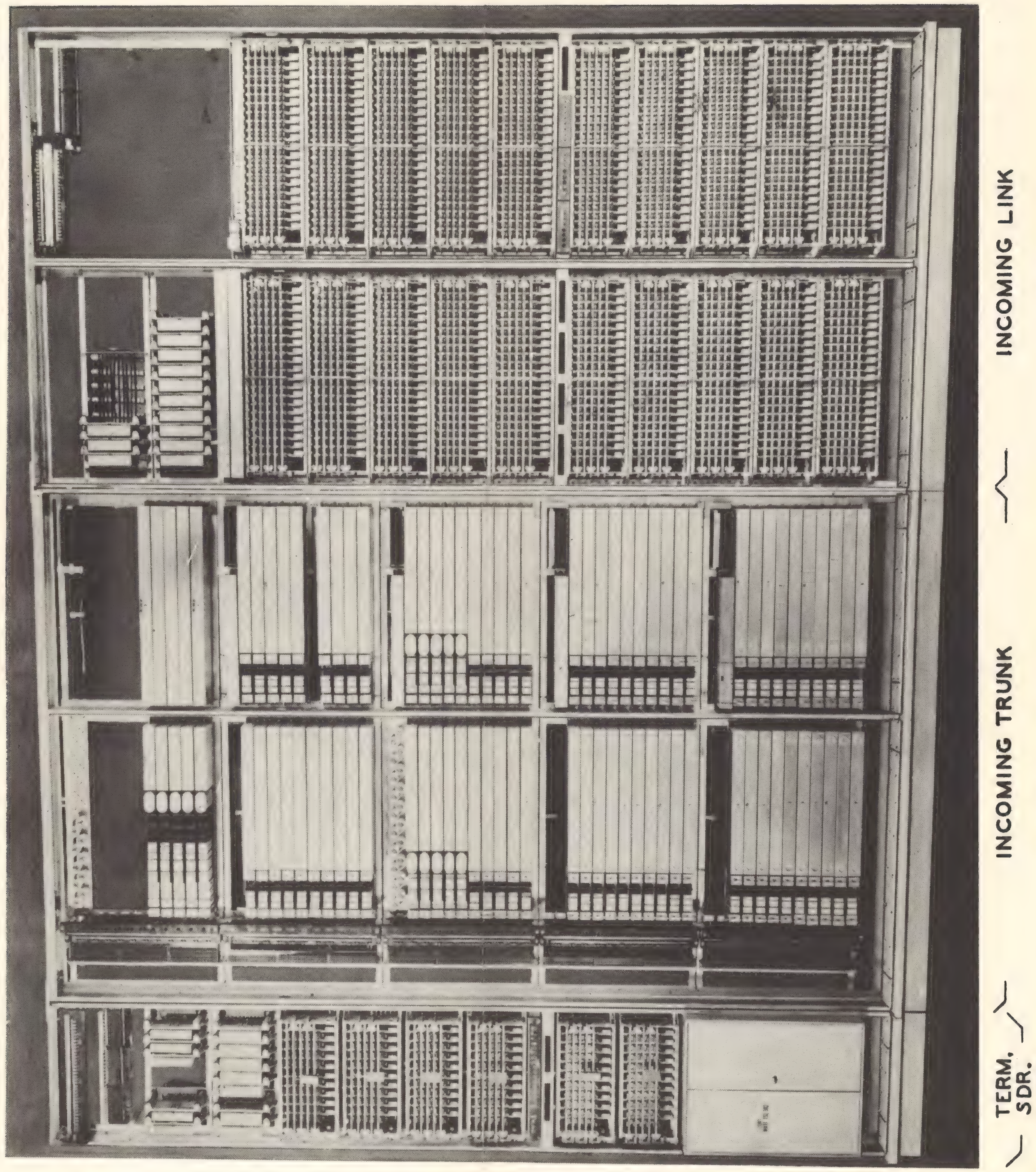
ORIGINATING MARKER CONNECTOR FRAME



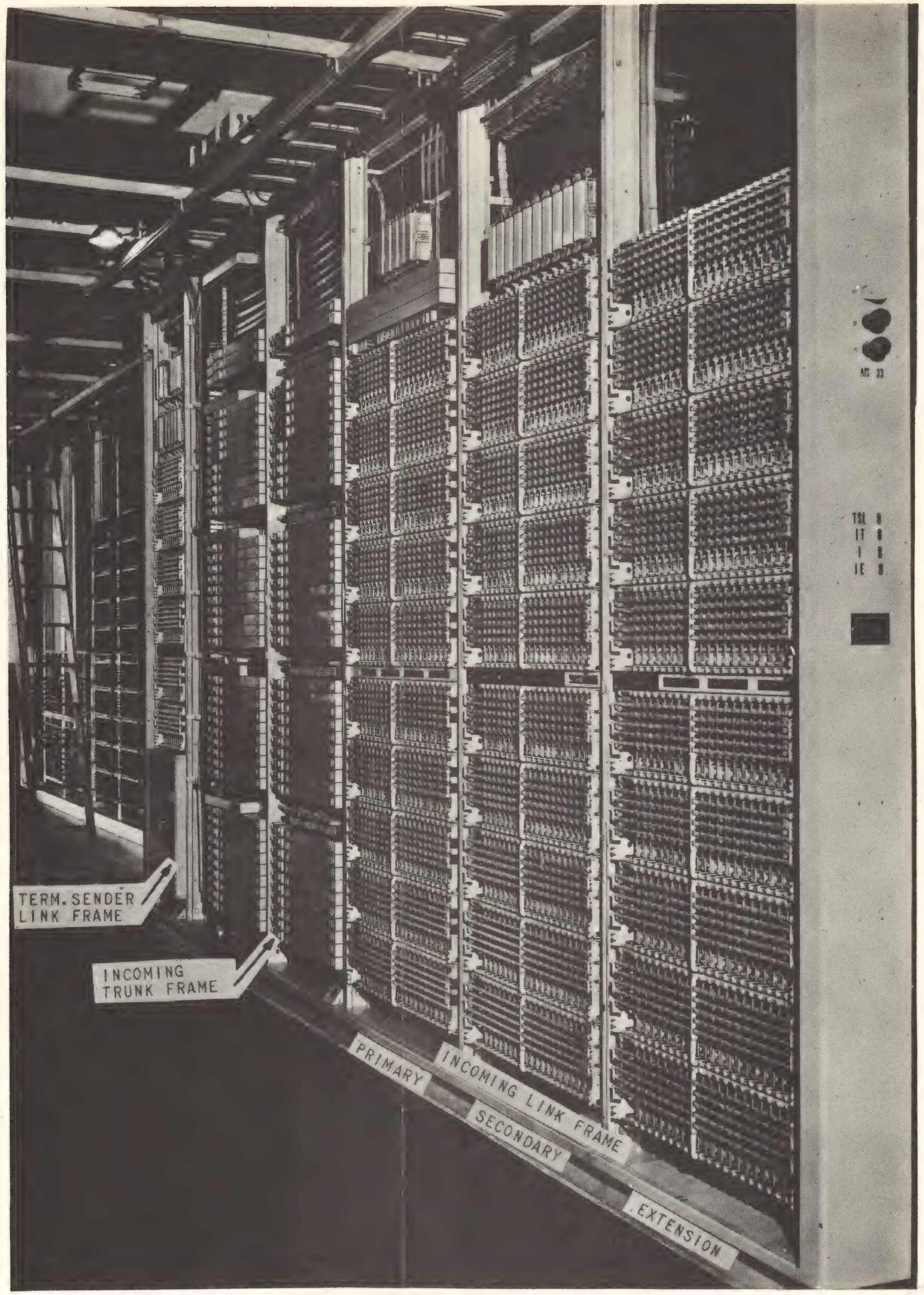
ORIGINATING MARKER FRAME
FRONT VIEW



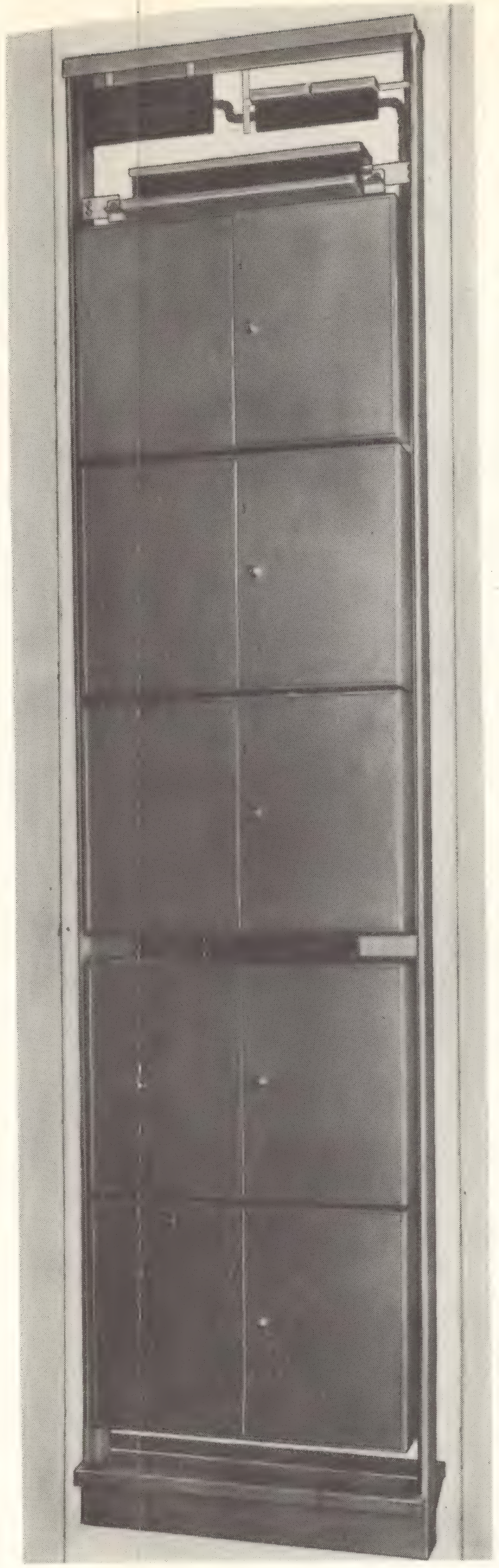
ORIGINATING MARKER FRAME
REAR VIEW



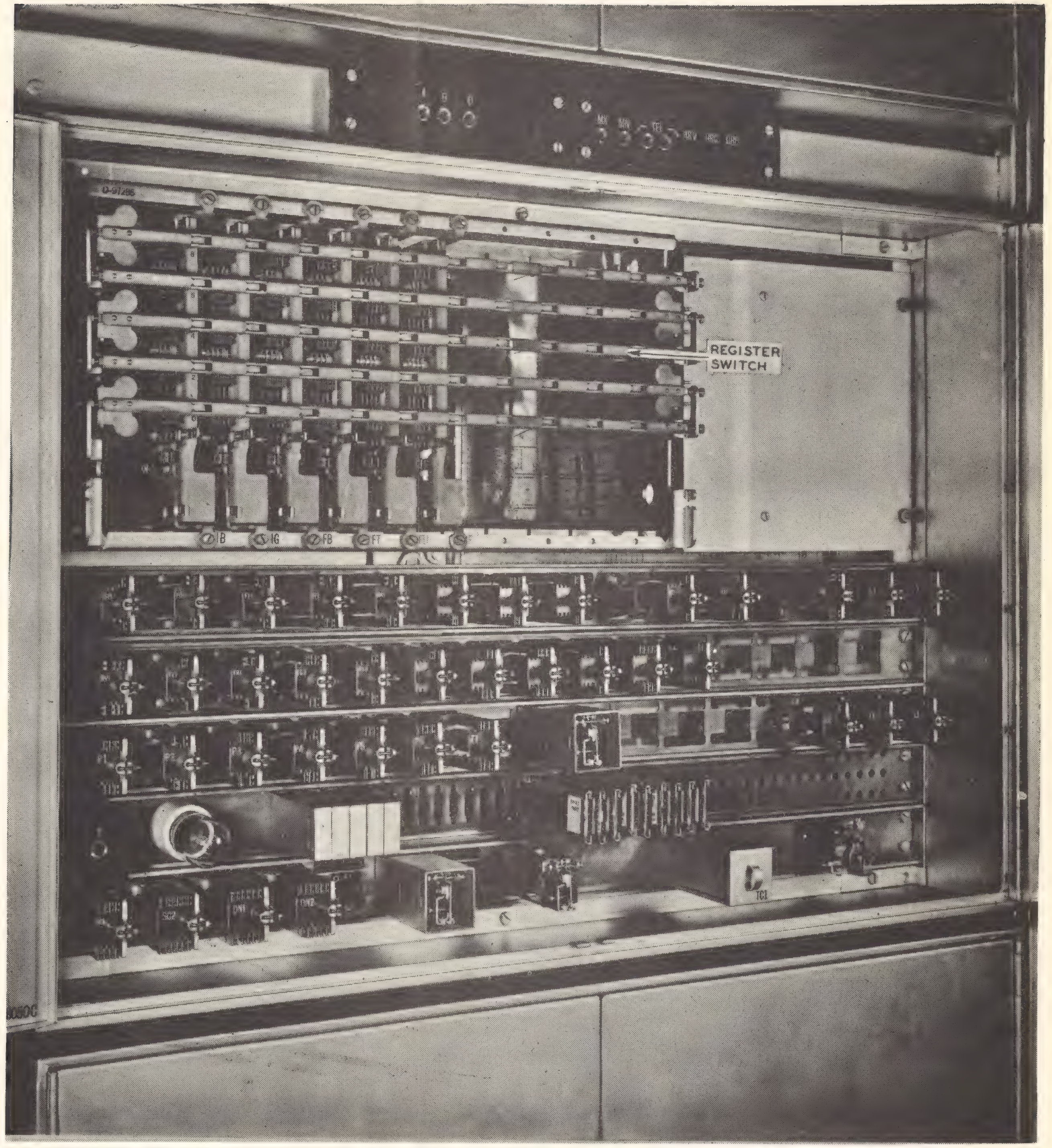
INCOMING FRAME GROUP



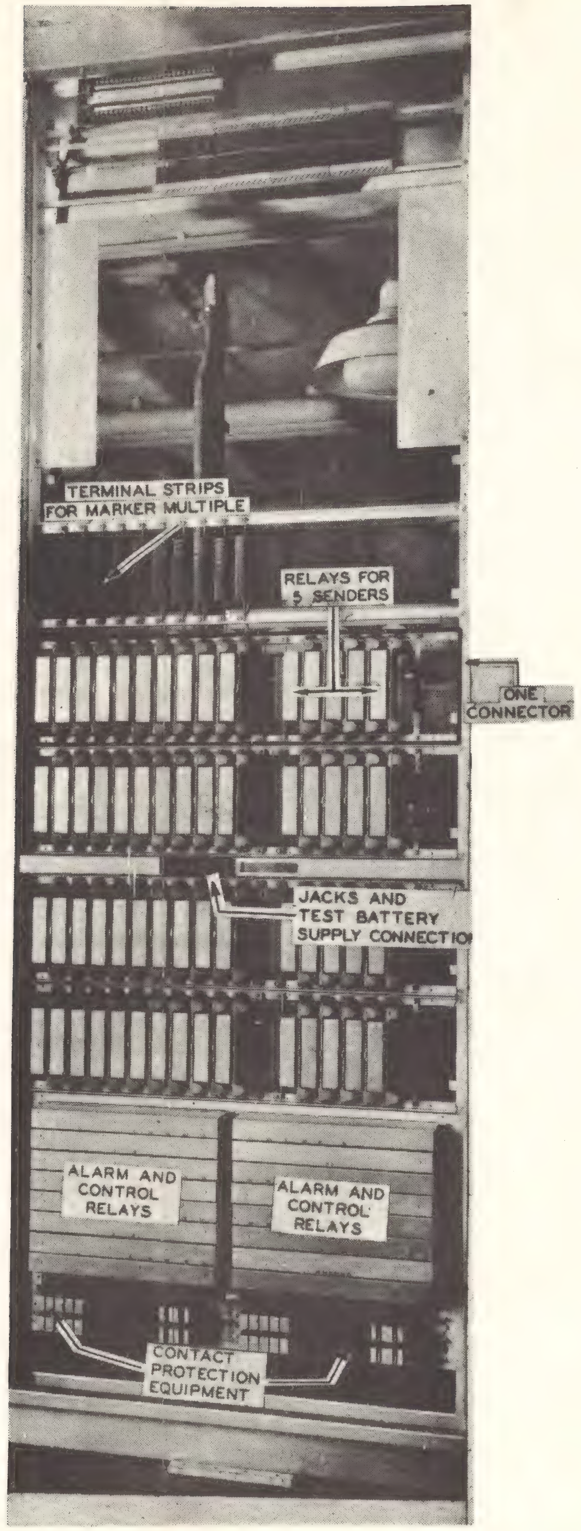
INCOMING FRAME GROUP
WITH 160 TRUNK INCOMING LINK FRAME



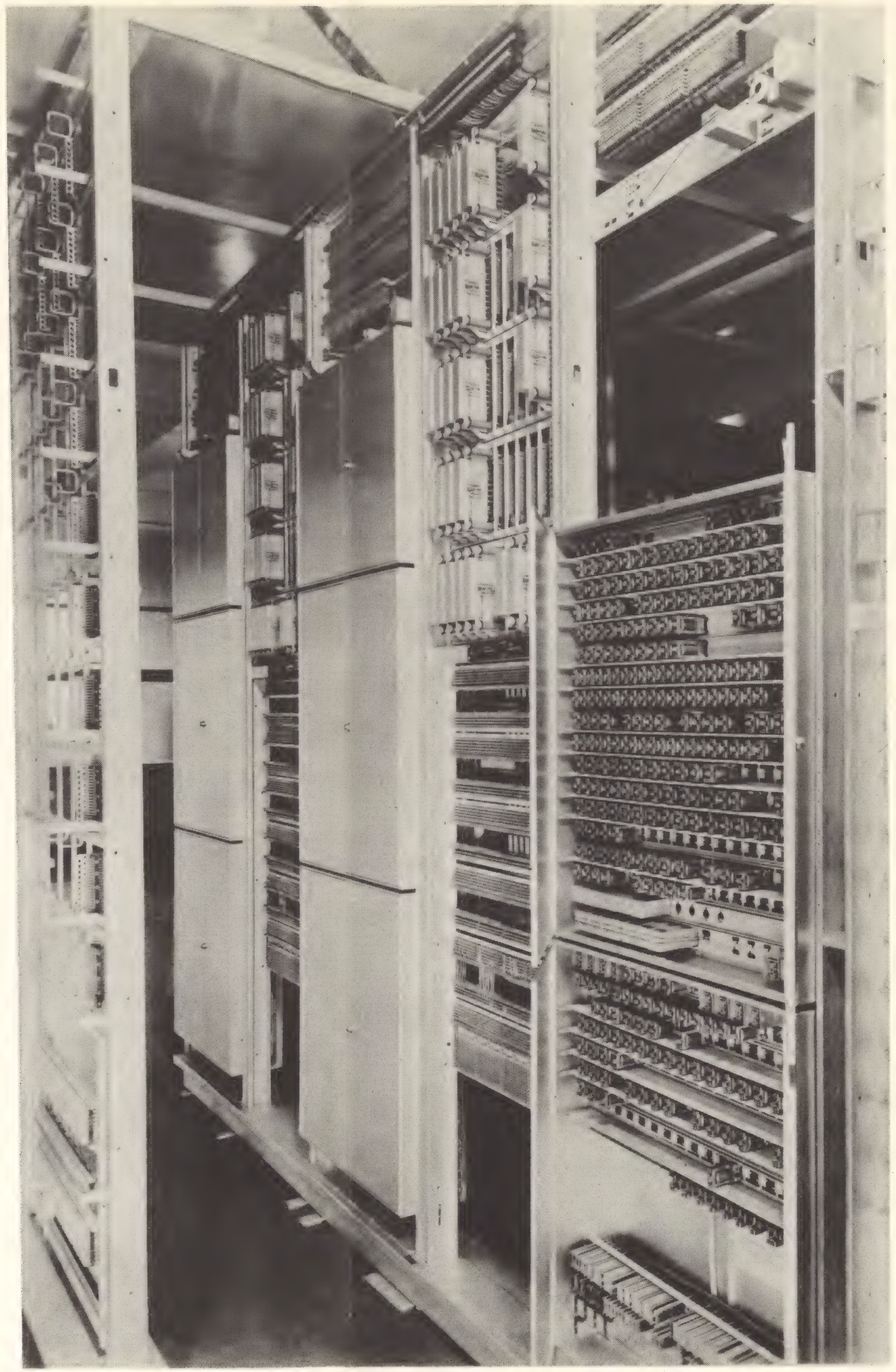
TERMINATING SENDER FRAME



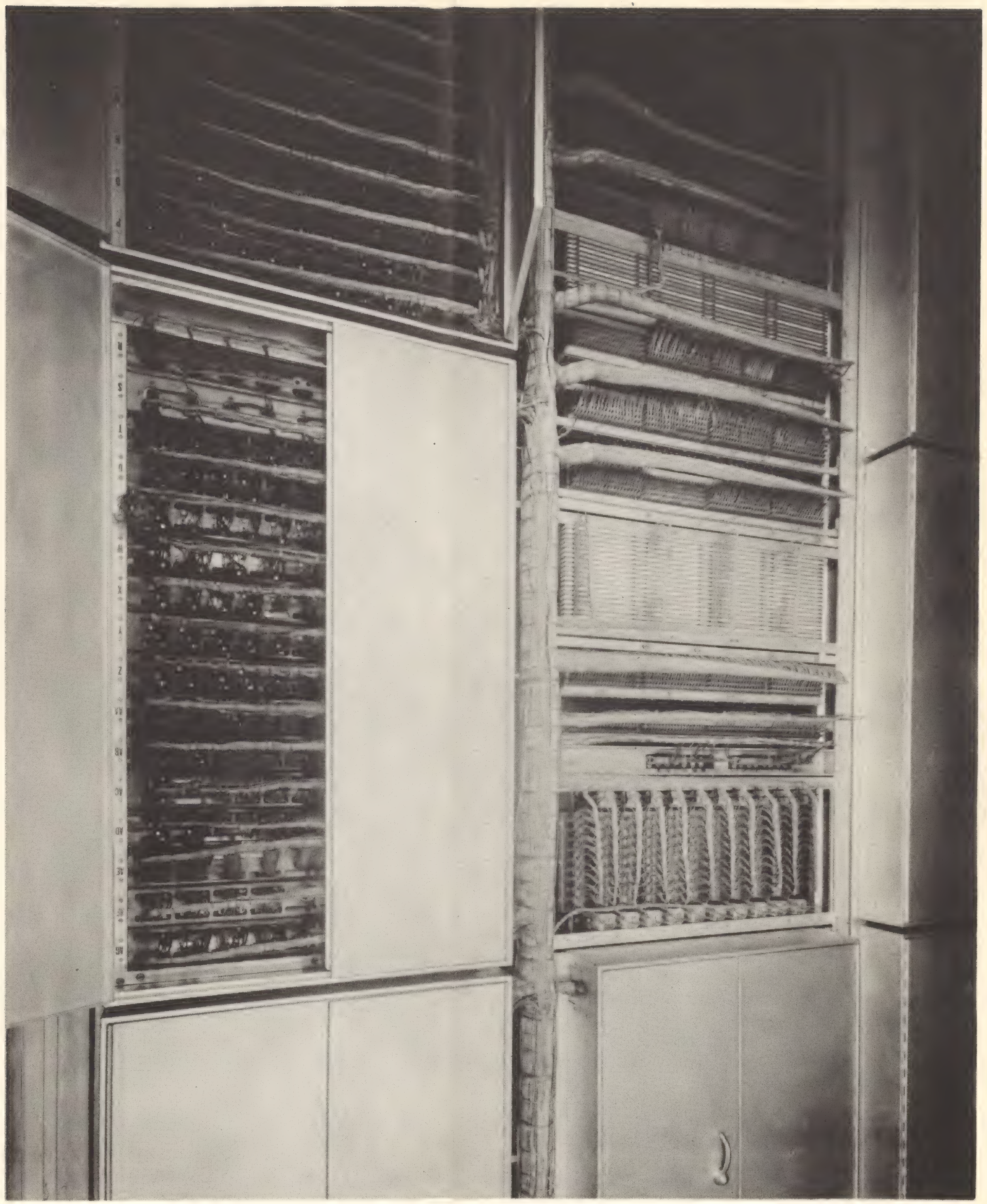
FULL SELECTOR TERMINATING SENDER


TERMINAL STRIPS FOR MARKER MULTIPLE
RELAYS FOR 5 SENDERS
ONE CONNECTOR
JACKS AND TEST BATTERY SUPPLY CONNECTIO
ALARM AND CONTROL RELAYS
ALARM AND CONTROL RELAYS
CONTACT PROTECTION EQUIPMENT

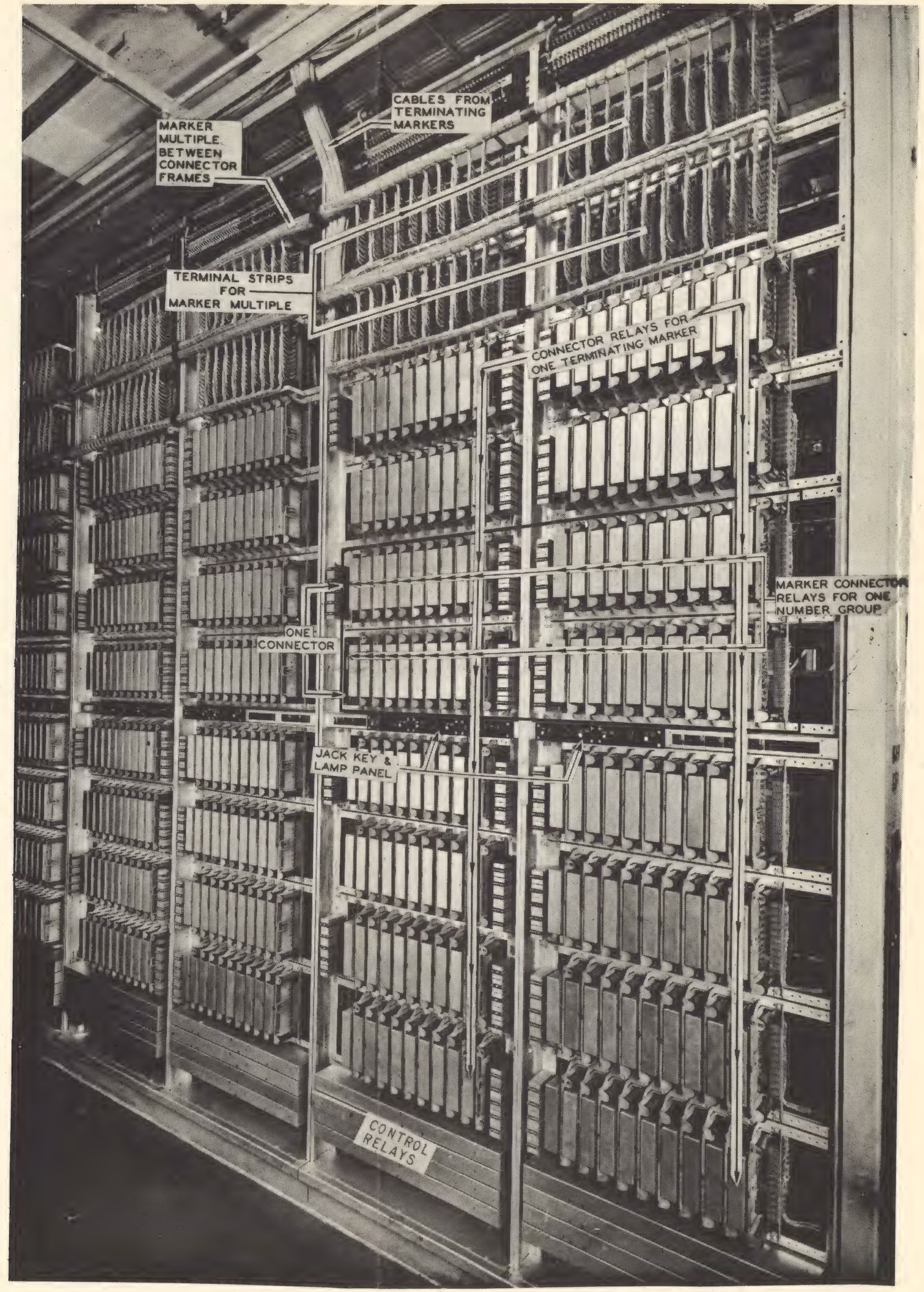
TERMINATING MARKER CONNECTOR FRAME



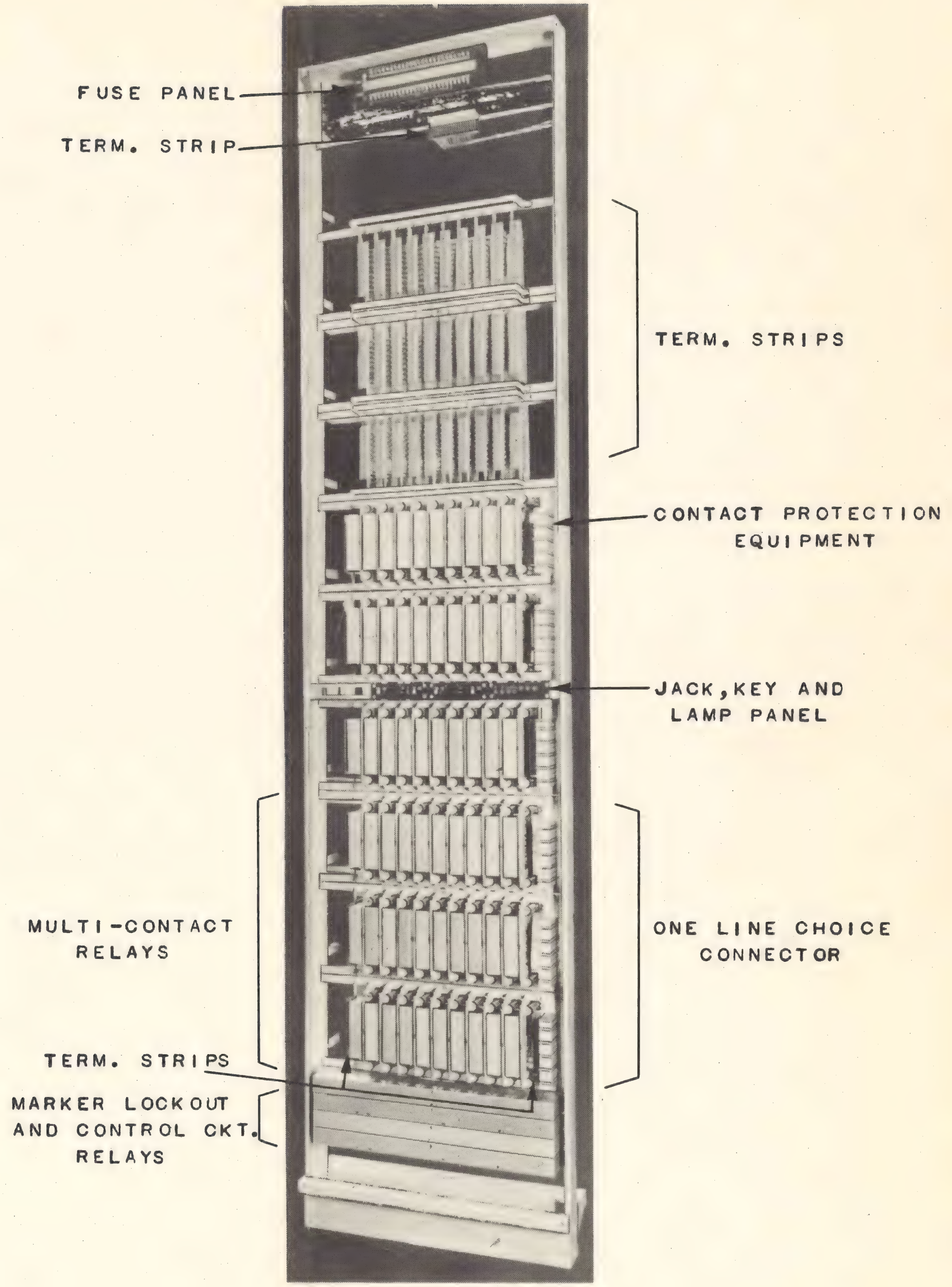
TERMINATING MARKER FRAMES



TERMINATING MARKER FRAME
REAR VIEW

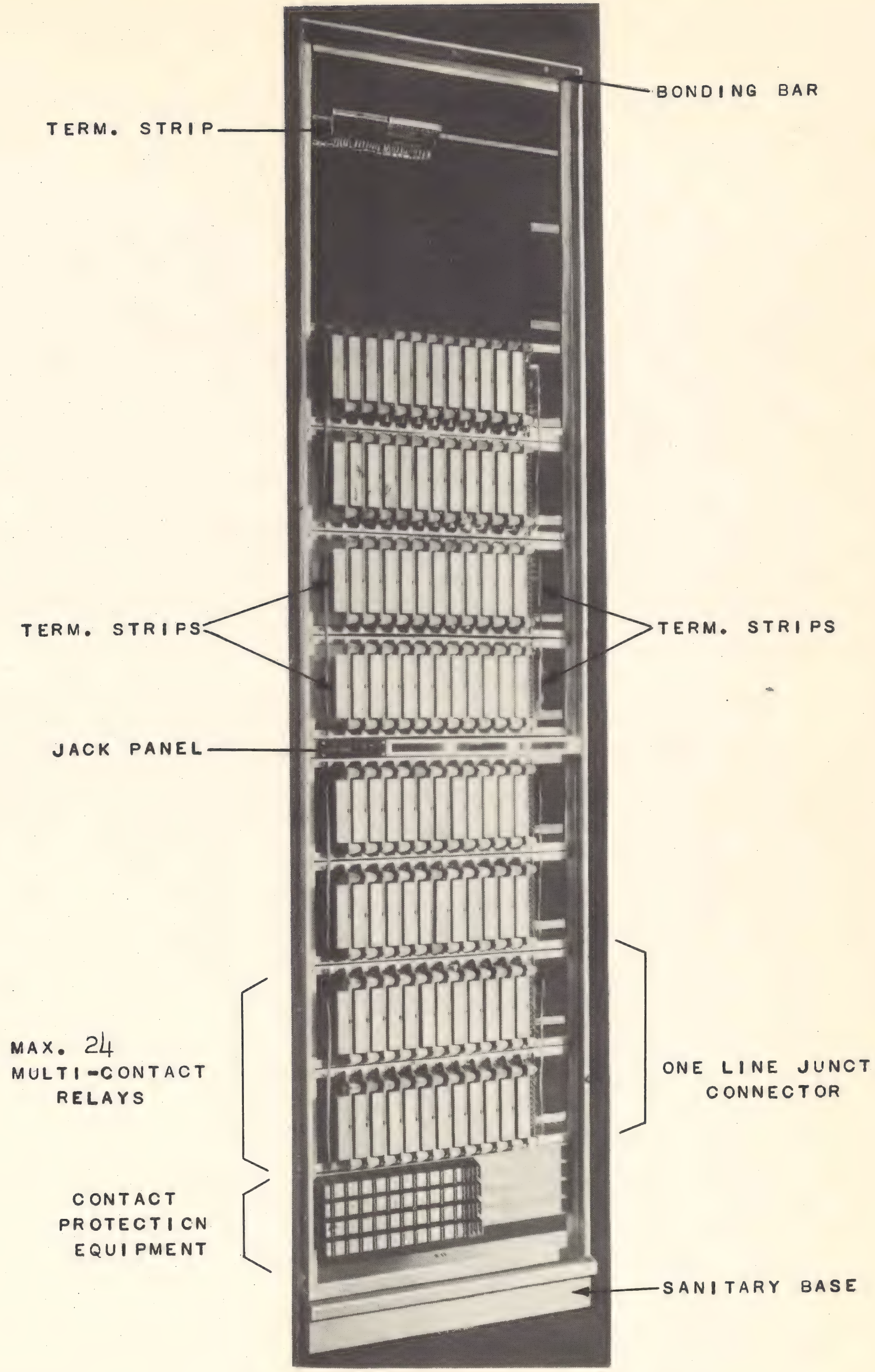

CABLES FROM TERMINATING MARKERS
MARKER MULTIPLE BETWEEN CONNECTOR FRAMES
TERMINAL STRIPS FOR MARKER MULTIPLE
CONNECTOR RELAYS FOR ONE TERMINATING MARKER
MARKER CONNECTOR RELAYS FOR ONE NUMBER GROUP
ONE CONNECTOR
JACK KEY & LAMP PANEL
CONTROL RELAYS

NUMBER GROUP CONNECTOR FRAME

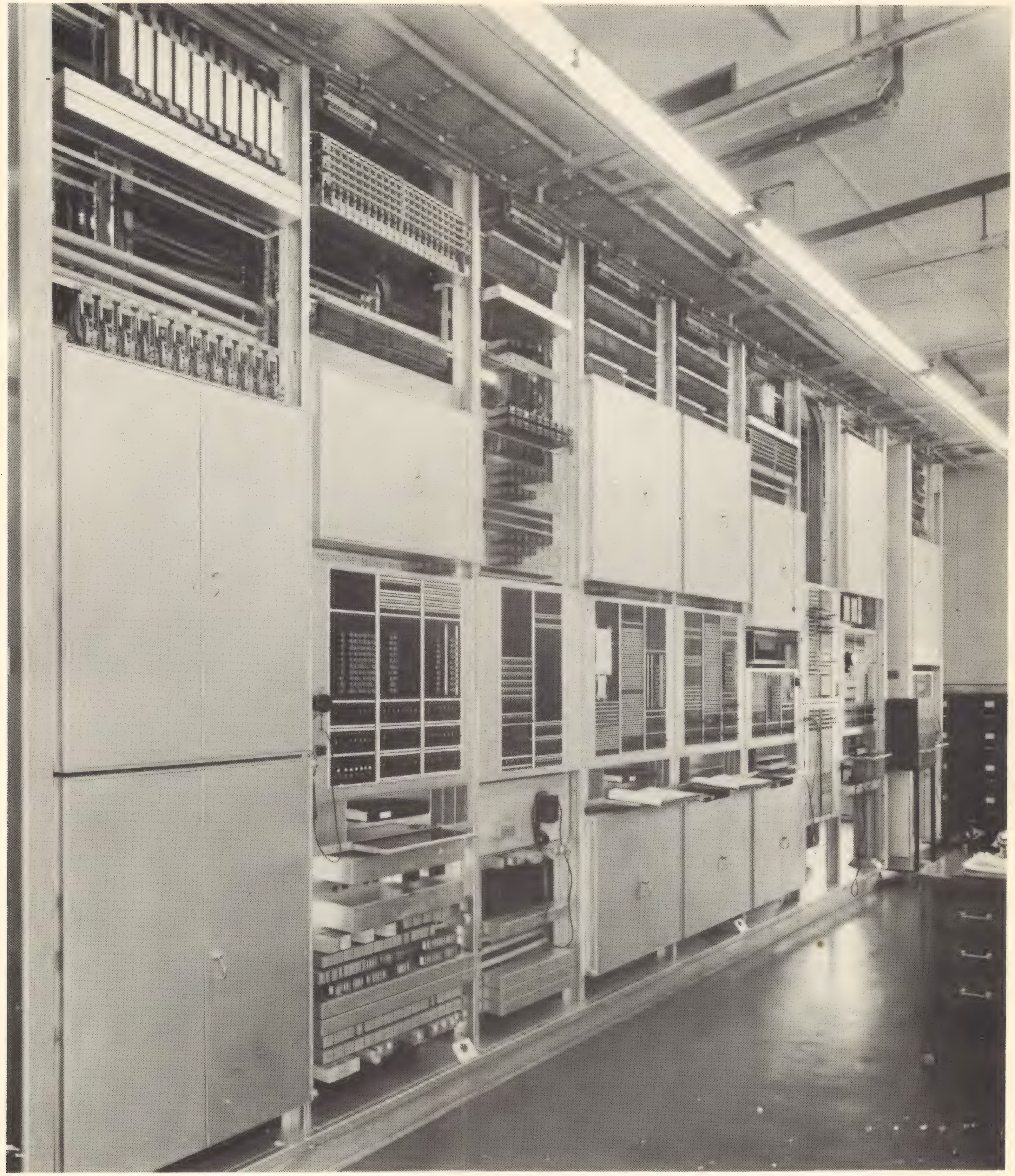


FUSE PANEL
TERM. STRIP
TERM. STRIPS
CONTACT PROTECTION EQUIPMENT
JACK, KEY AND LAMP PANEL
MULTI-CONTACT RELAYS
ONE LINE CHOICE CONNECTOR
TERM. STRIPS
MARKER LOCKOUT AND CONTROL CKT. RELAYS

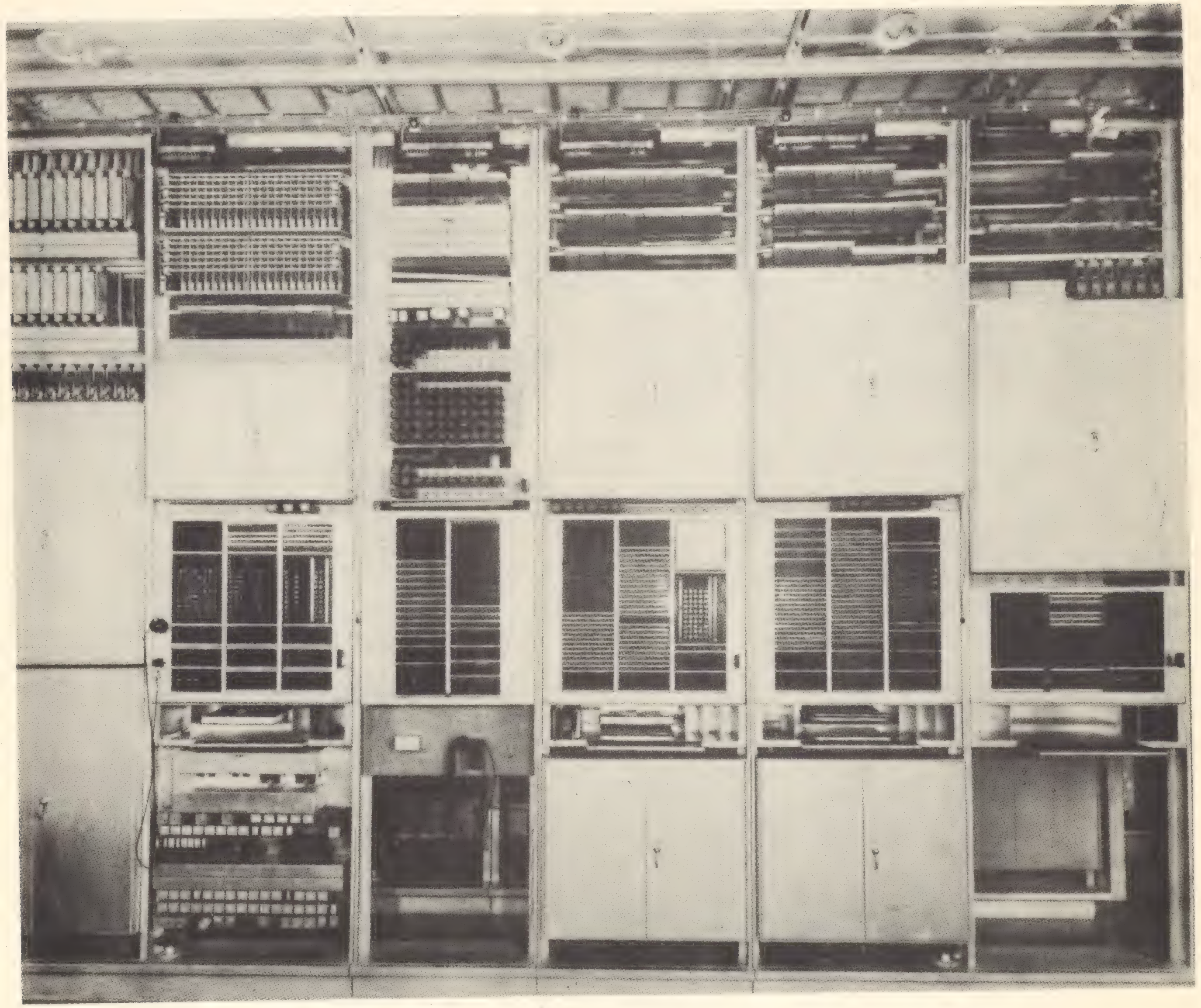
LINE CHOICE
CONN. FRAME


BONDING BAR
TERM. STRIP
TERM. STRIPS
TERM. STRIPS
JACK PANEL
MAX. 24 MULTI-CONTACT RELAYS
ONE LINE JUNCTOR CONNECTOR
CONTACT PROTECTION EQUIPMENT
SANITARY BASE

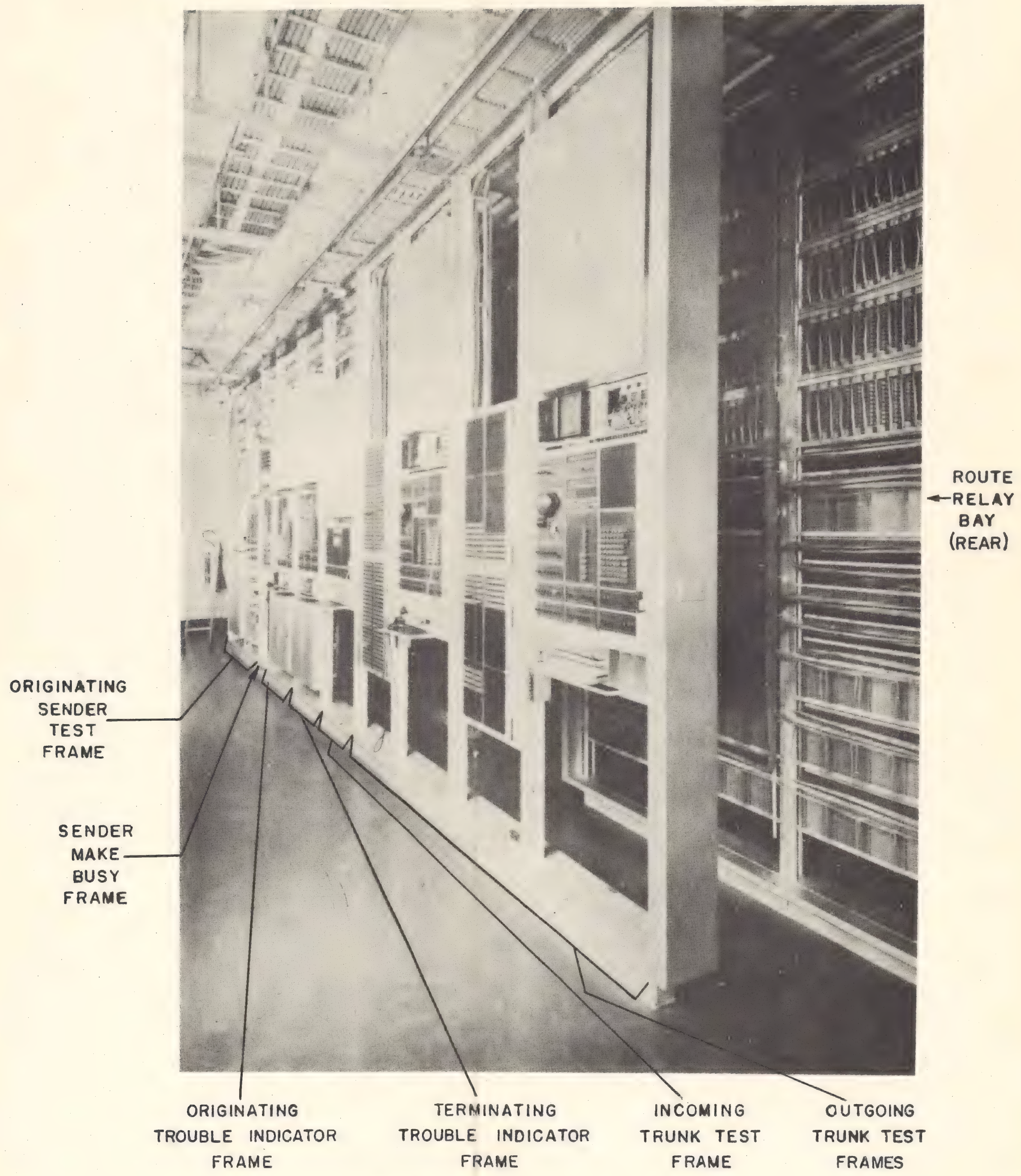
LINE JUNCTOR
CONNECTOR FRAME



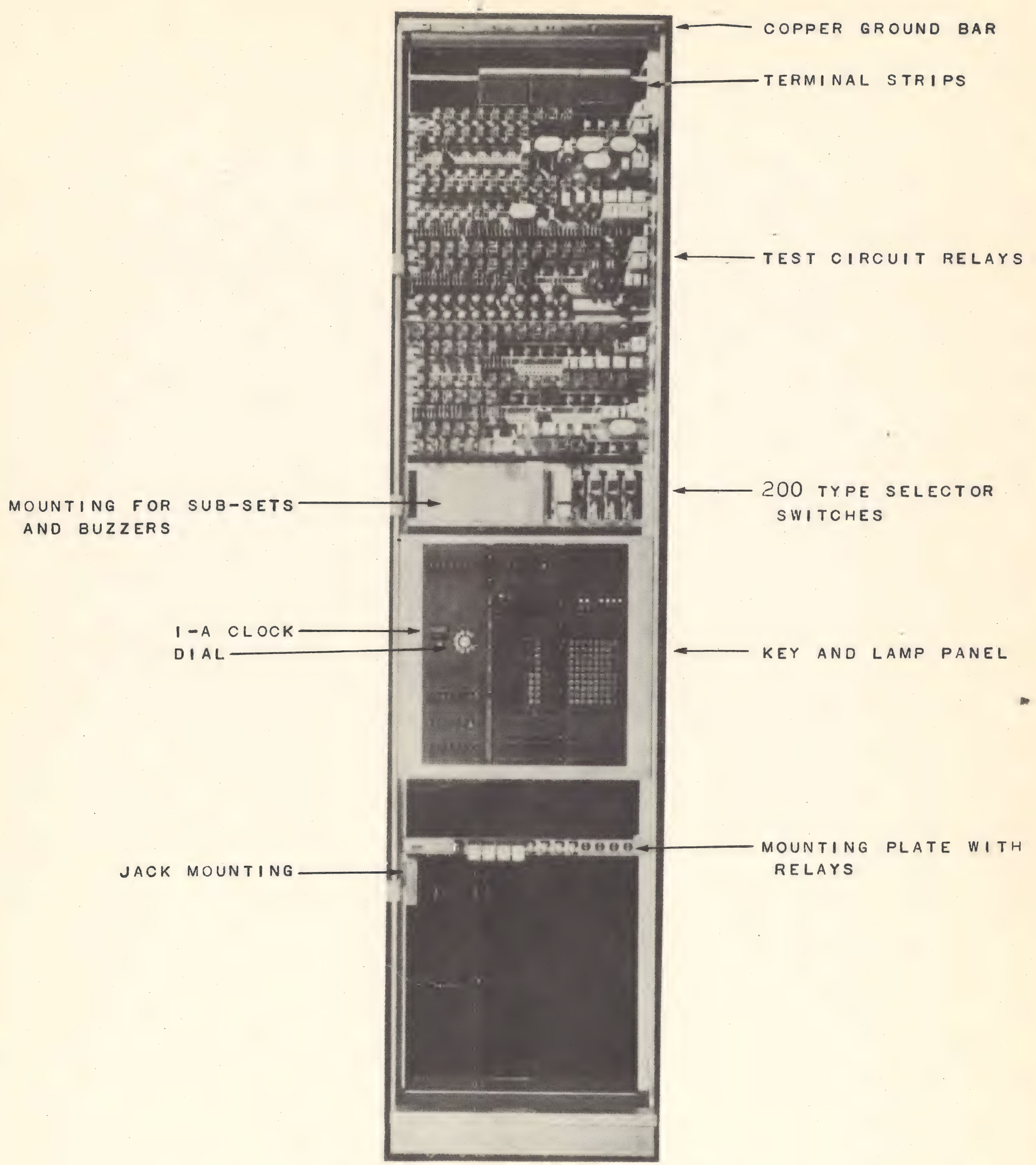
MAINTENANCE TEST CENTER



MAINTENANCE CENTER

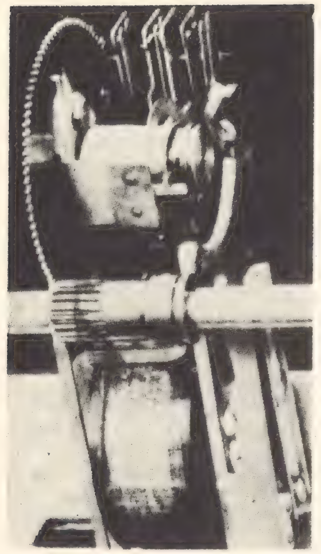

ROUTE RELAY BAY (REAR)
ORIGINATING SENDER TEST FRAME
SENDER MAKE BUSY FRAME
ORIGINATING TROUBLE INDICATOR FRAME
TERMINATING TROUBLE INDICATOR FRAME
INCOMING TRUNK TEST FRAME
OUTGOING TRUNK TEST FRAMES

MAINTENANCE CENTER



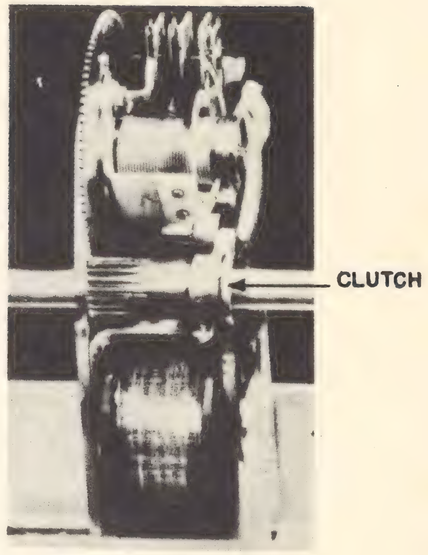
OUTGOING TRUNK TEST FRAME

TEST BAY

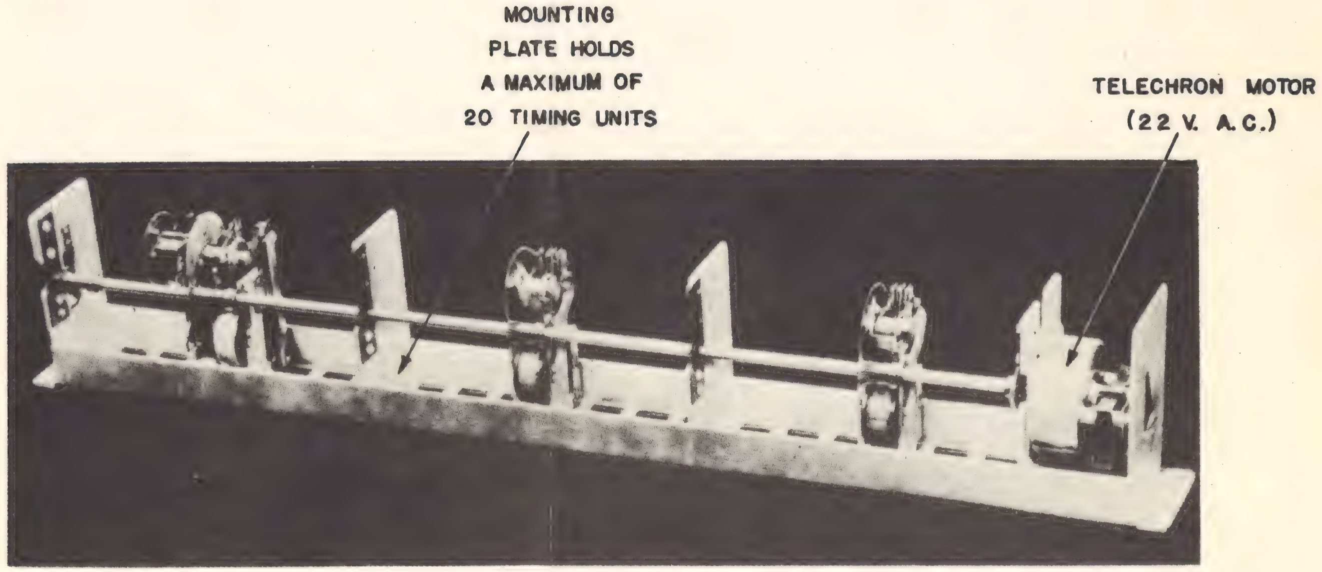


TIMING UNIT

FRONT VIEW



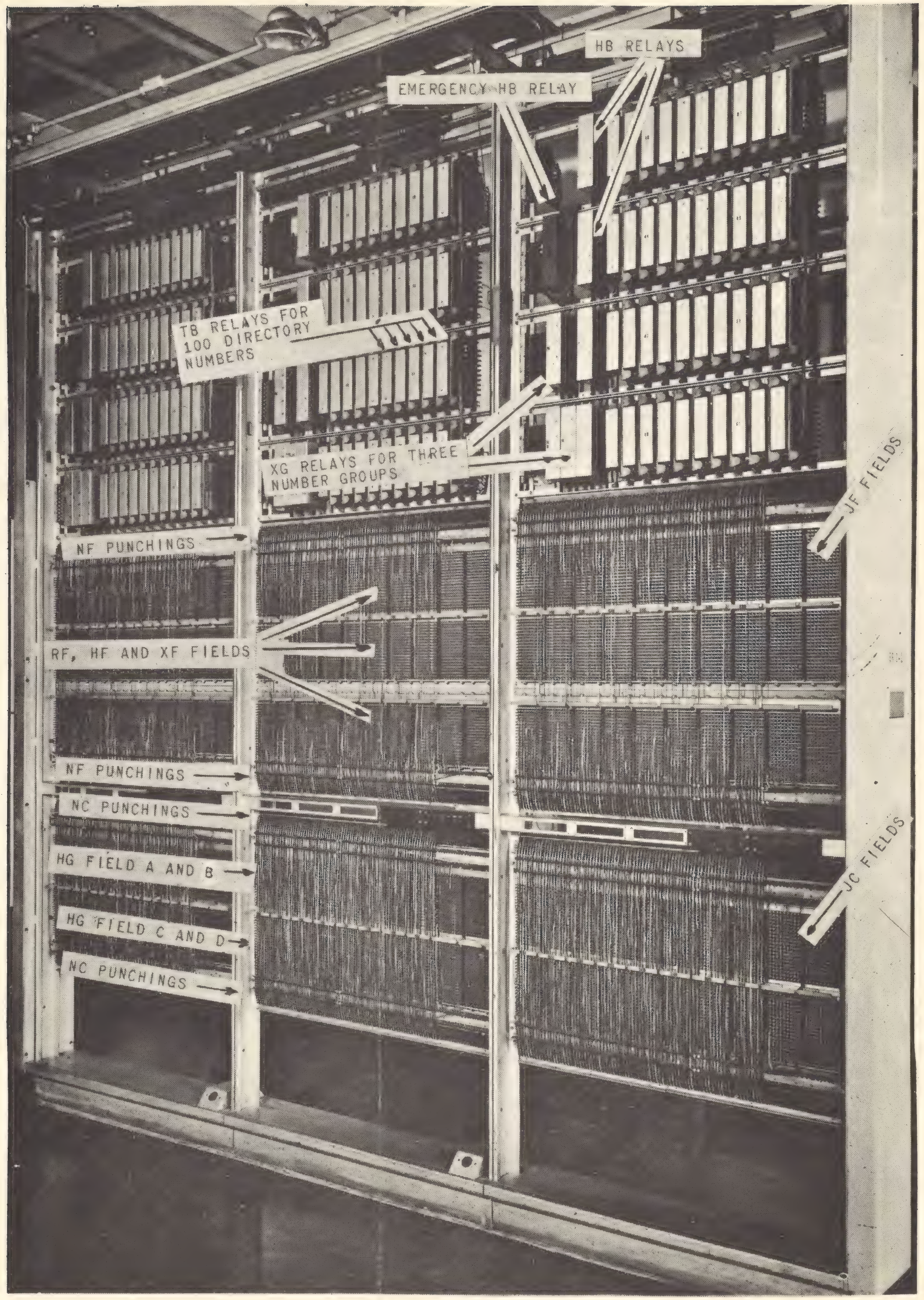
TIMING UNIT


MOUNTING PLATE HOLDS A MAXIMUM OF 20 TIMING UNITS
TELECHRON MOTOR (22 V. A.C.)

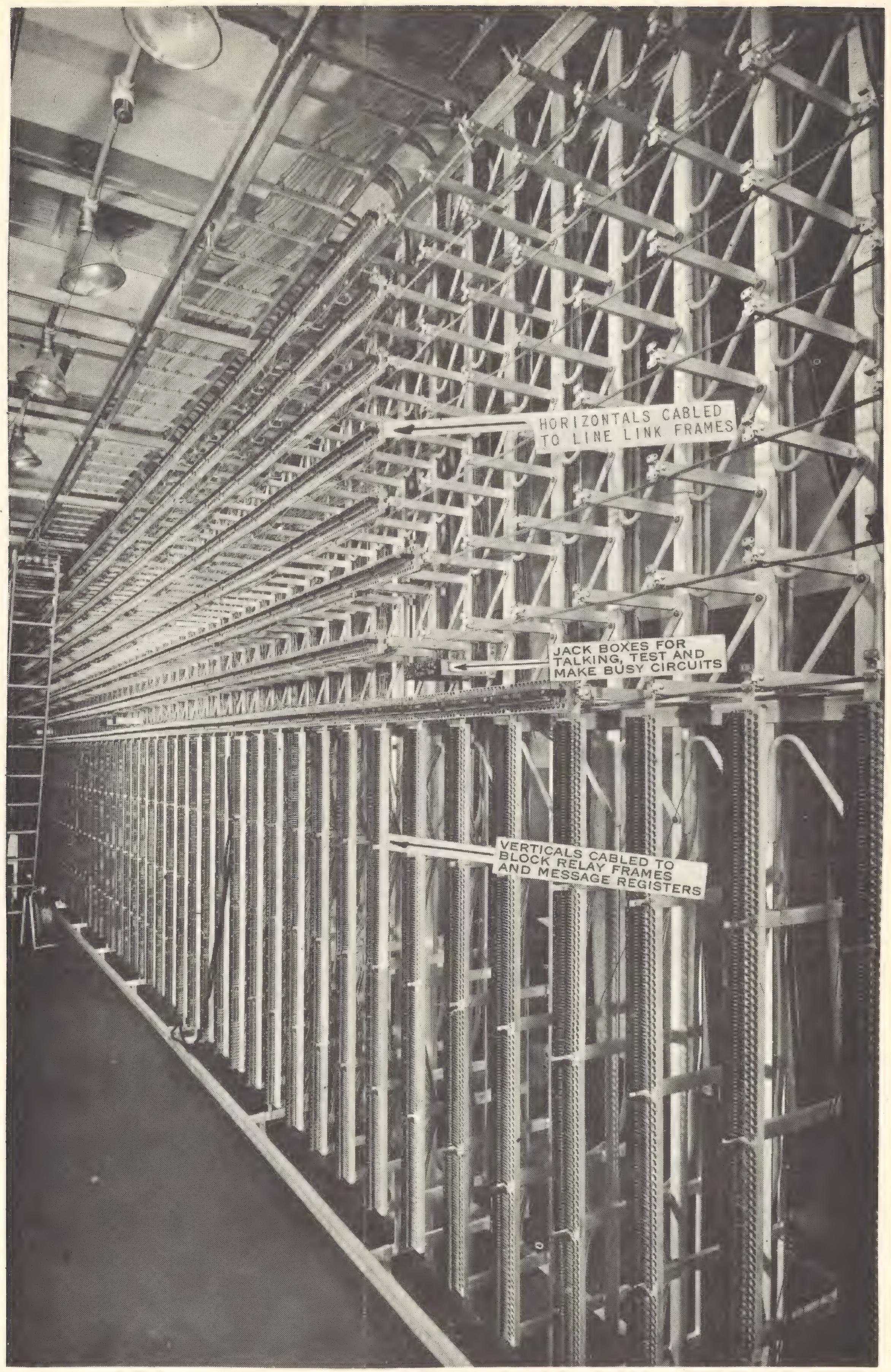
UNITS AND DRIVE

MULTIPLE REGISTRATION TIMING UNITS AND DRIVE

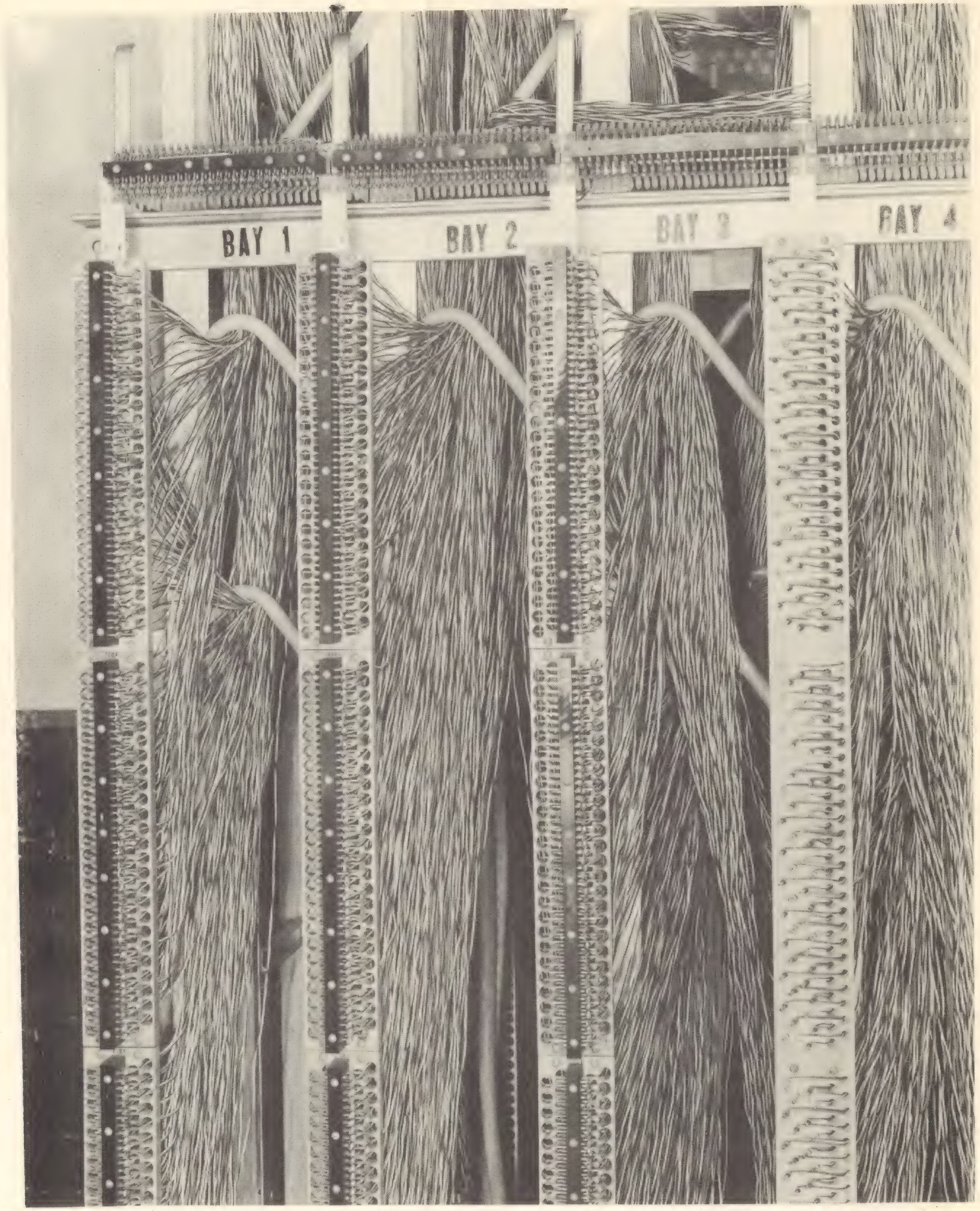
BLOCK RELAY FRAMES



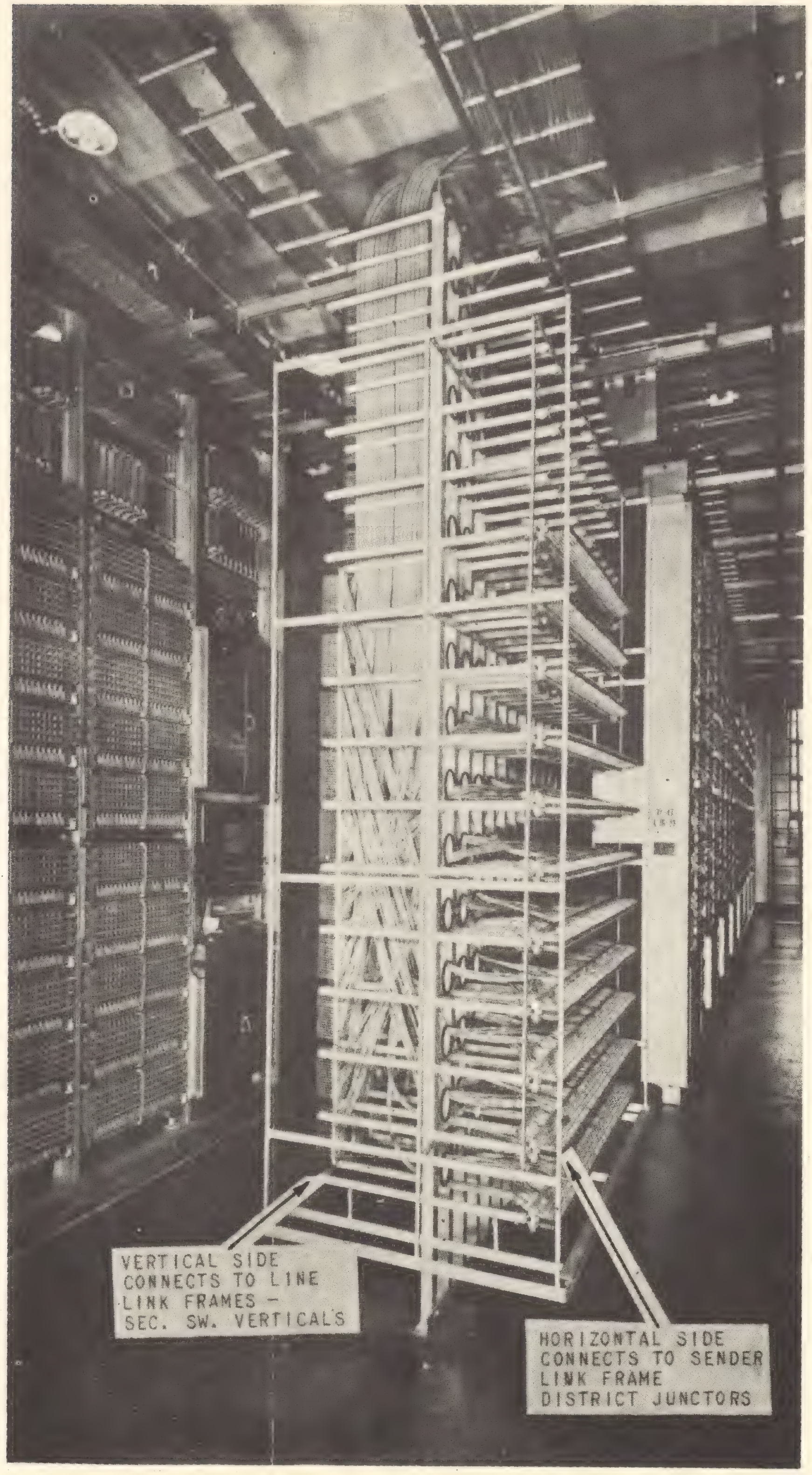
BLOCK RELAY FRAME


HORIZONTALS CABLED TO LINE LINK FRAMES
JACK BOXES FOR TALKING, TEST AND MAKE BUSY CIRCUITS
VERTICALS CABLED TO BLOCK RELAY FRAMES AND MESSAGE REGISTERS

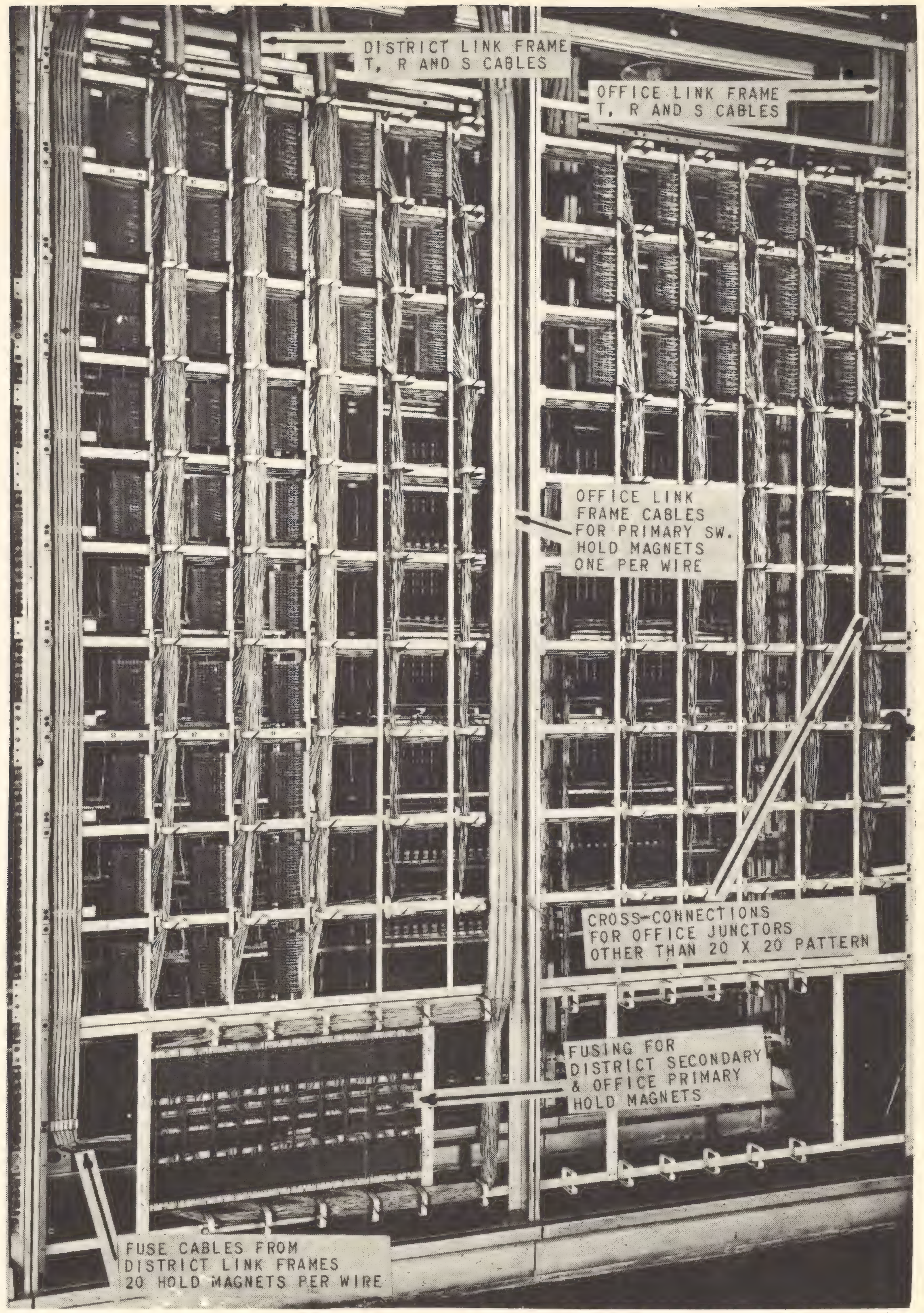
LINE DISTRIBUTING FRAME



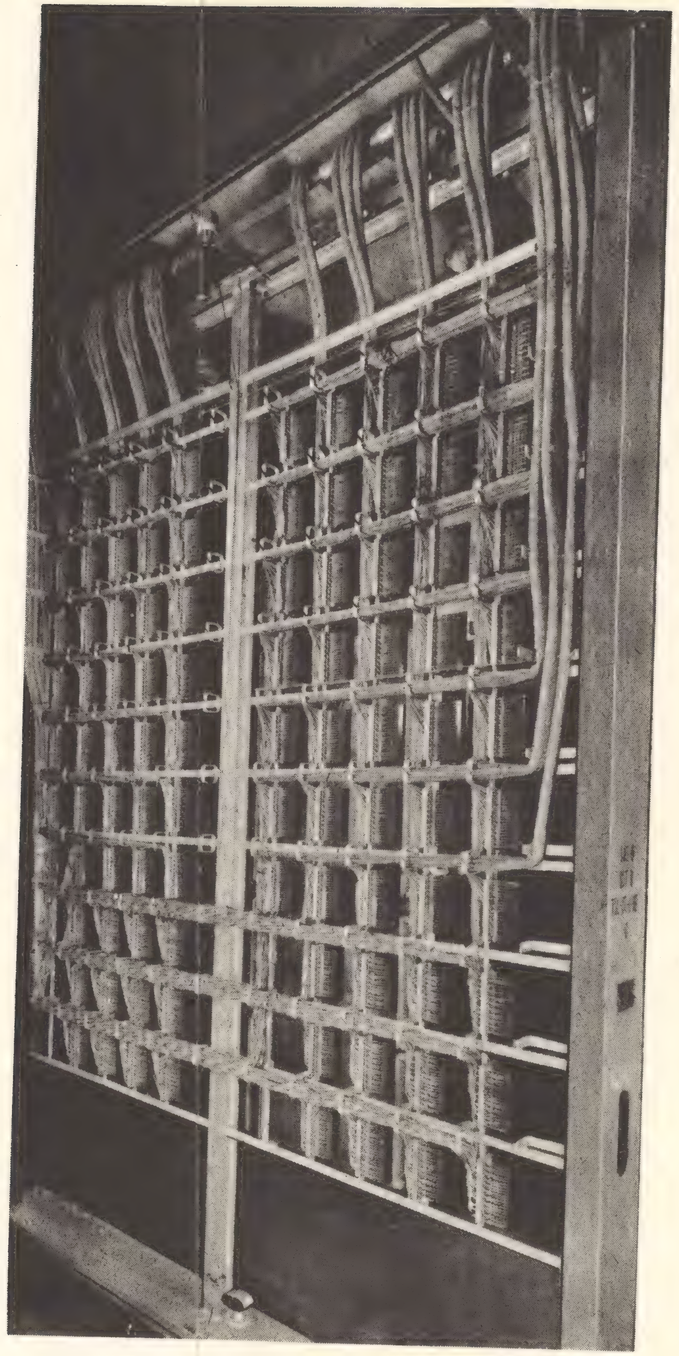
LINE DISTRIBUTING FRAME


VERTICAL SIDE CONNECTS TO LINE LINK FRAMES – SEC. SW. VERTICALS
HORIZONTAL SIDE CONNECTS TO SENDER LINK FRAME DISTRICT JUNCTORS

DISTRICT JUNCTOR GROUPING FRAME



OFFICE JUNCTOR GROUPING FRAME



LINE JUNCTOR GROUPING FRAME

CHAPTER 2

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CHAPTER 2

SECTION 1

PURPOSE, DESCRIPTION AND FUNCTIONS

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Line Link and Controller Circuit	SD-25553-01
Subscriber Sender Link and Controller Circuit	SD-25004-01
Subscriber Sender Link and Controller Circuit	SD-25554-01

MARCH 1954

PURPOSE, DESCRIPTION AND FUNCTIONS

GENERAL

This section covers the detailed circuit operation of the line link and sender link controllers from the start of a call to the connection to an originating sender and the release of controllers.

Controller operations have been broken down to their functional steps, such as selection of home or mate controllers, horizontal group selections, column selection, etc. The main objective of this section is that the student learn what the equipment must do, in what order it must be done, and what key relays are associated with each step.

LINE LINK AND CONTROLLER

PURPOSE

To provide means for connecting a subscriber's line or line circuit to a district junctor circuit and a sender link and controller circuit when a call is originated by the subscriber.

To provide means for connecting an incoming link and connector circuit and a line choice connector circuit, to a subscriber's line or line circuit, when a call is to be terminated to the subscriber.

DESCRIPTION

The line link frame provides a location for the subscriber's line equipment and a means to connect any line on the frame to the other crossbar switching equipment for both originating and terminating traffic.

The equipment arrangement of the line link frame is illustrated in RM 103. It consists essentially of one secondary bay, mounting ten 200 point 3-4 wire or 3-5 wire switches; one or more primary bays each of which mount ten 200 point or ten 100 point crossbar switches; and the necessary controller equipment. The terms primary and secondary are arbitrary terms used on all types of link frames throughout the crossbar system.

Primary bays may be multipled together by connecting the ten levels or horizontals of each switch to those on the same horizontal level in the preceding bay, thereby giving 20, 30, 40, 50, 60, or 70 subscribers access to a common group of trunks called "line links" RM 104. Traffic conditions determine how many primary bays should be multipled together. As both outgoing and incoming calls are completed over the horizontals, both originating and terminating traffic have to be considered in loading the line links. Like numbered switches of primary bays are called "horizontal groups," and the same ten verticals on each corresponding horizontal group are known as a "vertical group," or "column". There will be from two to seven "vertical groups," or "columns" on a line link frame, each of which accommodates 100 subscribers' lines, except the first column, which will serve only 90 subscribers' lines, because the zero vertical of each switch in that column is reserved for no-test calls.

Flat rate, individual message rate and coin lines require 4 wire primary switches. Two party message rate lines require a 5 wire primary switch on account of the message register lead for the second party. Twenty 5 wire vertical units can not be mounted on the present switch framework without increasing its length and consequently the width of the frame. Therefore, 190 point (19 verticals) switches are used instead of 200 point on line link frames serving two party message rate lines.

The 100 horizontals of the primary switches are distributed to the horizontals of the secondary switches by means of 100 line links in the local cable, each primary switch having one line link to each secondary switch. RM 104 illustrates this "horizontal to horizontal" line spread. Horizontal strapping is employed to extend the line links across the verticals of the secondary switches.

The secondary switches are 200 point 3-5 wire having ten 5 wire vertical units upon which terminate ten district junctors for originating traffic; and ten 3 wire vertical units for terminating ten line junctors used by terminating traffic; thus, outgoing from the line link secondary switches there are 100 district junctors and 100 line junctors.

As previously stated, each subscriber has the exclusive use of one vertical of a primary switch. These verticals are numbered 0 to 9 in the left half of each switch and 0 to 9 in the right half of each switch. The switches are numbered from bottom up, 0 to 9; thus, referring to RM 103, the lines on the left half of all switches in the primary bay adjacent to the secondary bay count 0 to 99 for the 00 column. The lines on the right half of all the switches in the same bay count 0 to 99 for the 01 column. Similarly, the lines on the next primary bay count 0 to 99 for columns 02 and 03, etc., progressing in the column count from bay to bay throughout the line link frames in the office. The location of a particular line is given as 0365; that is, column 03, horizontal group 6, vertical 5. These numbers are not subscribers' directory numbers, but compare with the panel and jack in manual, or the group and terminal in panel offices.

The line relay for a particular line is located beneath the associated primary switch and the holding magnet of the vertical acts as the cut-off relay for the line. The ten subscribers' lines located on a particular switch and column are treated as a group for circuit purposes, each group of ten having a start lead to the controller circuit. In addition, besides the start leads, each line is provided with a test lead to be connected to the controller for the purpose of identification of the calling line. In order to permit the controller to gain access to these test leads and also to the windings of the primary holding magnets, each group of ten lines is provided with a line connector circuit consisting of two relays which may be operated by the controller. The line connector relays are located adjacent to the associated group of line relays.

Each line link frame is provided with a controller whose function it is to recognize a calling line, assist the sender link controller in selecting an idle line link and an idle district junctor, and in operating the necessary selecting and holding magnets for connecting these paths to the calling line. Since the controller is offered for the use of a group of lines which may vary in size from 190 to 690, its failure would put that number of lines out of service if no provision were made for emergency operation. As a protection against this, line link frames are arranged to work in pairs, the controller on one frame acting as an emergency controller circuit for the other. This is known as "Home" and "Mate" control operation. Associated with each controller is a controller connector circuit, consisting of two sets of relays, one of which connects the test leads from the frame to its "home" controller and the other to the "mate" controller. Should there be an odd number of line link frames, an extra control circuit is provided and mounted on the miscellaneous relay rack, to serve as an emergency circuit for the odd frame.

The start circuit on each line link frame consists of two channels referred to as "A" and "B" channels. Under normal operation, the "A" channel will be used for each call and the operation of a line relay will cause this channel to function to choose the home controller to handle the call. When due to a trouble condition, the home controller is not available to handle calls, the "B" channel of the start circuit will function and the controller on the mate line link frame will serve the call. Under these conditions, both line link frames will use the same controller each frame alternating in its use. If calls are waiting until the trouble condition is cleared.

FUNCTIONS

ORIGINATING CALLS

The line link controller in cooperation with the subscriber sender link controller is responsible for connecting a calling line to a district junctor and through the subscriber sender link to a subscriber sender. This process takes place before dial tone is given to the subscriber.

RM 105 or ~~RM 2-1~~ may be of assistance in interpreting the functions described below:

Identification of Calling Line: In order to connect a particular calling line to a line link and district junctor, the line link controller must first identify the calling line. This is done by means of the horizontal group circuit in conjunction with a series of "vertical group" relays in the controller. All groups of ten lines each in the same horizontal group will give the same horizontal group indication. Each of these groups will, however, give a different vertical group indication so that by means of the two indications the control circuit will recognize a particular group of ten lines. It will then operate the line connector relays to connect the test leads and holding magnet operating leads for this group to the controller. Since the test leads for only one group of ten lines are connected at a time to the controller it can identify which one of the ten is calling.

Order of Handling Calls: When simultaneous calls exist in more than one horizontal group a call in the lowest numbered horizontal group will be handled first. After this call is connected to a sender a call in the next lowest number horizontal group will be handled. Calls waiting in the horizontal groups which have been served for one call are locked out until one call has been served in each other horizontal group which has calls waiting. Where simultaneous calls exist in the same horizontal group, the call may be handled in the lowest numbered vertical group and highest numbered vertical, or the lowest numbered vertical and the highest vertical group.

Choice of Idle District Junctor: Assuming that there are idle district junctors available on each secondary switch and that waiting calls are distributed evenly over the horizontal groups, the controller will assign calls alternately to two groups of ten district junctors until nine district junctors in each of these two groups are busy. Thereafter, it will assign calls to succeeding groups of ten district junctors on the frame until nine calls have been assigned in each group. One district junctor in each subgroup is always held in reserve until no district junctors but those reserved are available for calls. When this condition arises, the reserved district junctor will be assigned. The alternation in assignment for the first two groups referred to above insures that a subscriber will not be assigned the same facilities on a second attempt during periods of light traffic.

The purpose of holding one district junctor in reserve in each group of ten is to minimize the possibility of "blocking." Blocking of calls in the line link primary-secondary spread occurs when there are idle line links available in a particular group but no district junctors. Since the district junctors are multipled to a number of line link frames, they can be made busy by any line link frame having access to them. The reserve feature, therefore, tends to insure full usage of the links on the various frames by increasing the possibility of an idle line link finding an idle district junctor.

Choice of Idle Line Link: For each group of ten district junctors appearing on the same secondary switch, there is one line link from the horizontal group in which a calling line appears. Although the previous paragraph discussed the normal rotation in the assignment of calls to the various groups of ten district junctors this rotation is, of course, affected by whether or not there is available a line link into the particular secondary switch on which a given group of district junctors appears. The ten line link test leads for the horizontal group are connected by the horizontal group connector relay to the controller where the busy line links operate relays which bar the use of the corresponding subgroups of district junctors. Of those line links which are idle, the one corresponding to the subgroup of districts which would normally be assigned in the regular assignment sequence will be used. The assignment of a group of district junctors is made only when there is access available from the district junctors in question through the subscriber sender link to an idle sender.

District Junctor Lockout: Since a group of district junctors appears on more than one line link frame (as discussed later) there will be times when more than one line link frame will wish to assign a call in the same district junctor group. There is a lockout chain between the various appearances of a group of district junctors. The line link frame which first succeeds in gaining access to the group will lock out the others momentarily until it has obtained an idle district junctor and the calling line has been connected to a sender.

Class of Service Indications: In general, line link frames are classed as flat rate, message rate, message rate two party, and coin. Individual message rate and flat rate lines may be located on the same line link frame; however, two party message rate lines require a five wire switch and for this reason they must be located on separate line link frames. Coin lines require a coin district junctor which differs from that serving flat or message rate lines, and, therefore, they too must be located on separate line link frames. However, under each of these classifications, there may be different classes of subscribers requiring separate treatment on certain calls. Thus, one flat rate subscriber may be permitted unlimited calls in one metropolitan zone while he should be charged for calls to another zone, while others may be permitted unlimited calls to all zones. Provision is made for each line to give a class of service indication to the subscriber's sender. In assigning subscriber lines to primary vertical units, it is necessary that all lines entitled to the same class of service be assigned to the same relative location on each switch of each column of that line link frame. For example, if a 1MR line was assigned to 0001, (column 00, horizontal group 0, vertical 1) on line link frame 0, and assuming that this line link frame has four columns 00, 01, 02, 03, all of the following would be reserved for 1MR lines: 0011, 0021, 0031, 0041, 0051, 0061, 0071, 0081, 0091, 0101, 0111, and etc. to 0391, making a total of 40 1MR lines. The verticals on the mate frame do not have to be assigned to the same service, although either control circuit handles the call.

Ten verticals located one above the other of a column are called a "vertical file;" thus, in the above example, we may say vertical file #1 of each column of lines in the line link frame serves the same class of service, or 1MR in this case. When a group of ten lines is connected to the control circuit, a line in a given position in the group of ten will give the same class of service indication, regardless of which group of ten lines on the frame it is in. Any line link frame may give a total of four class of service indications to the sender. These indications are transmitted to a group of ten terminal strip punchings which are cross-connected to the class of service leads to the sender as required for a particular line link frame. The sender will later transmit the calling line, class of service indication to the originating marker, which will then set the district junctor to charge as required in accordance with the class of service, or it will route the call in various ways, depending upon which class of service the calling subscriber is entitled. ✓

Closure of Crosspoints: Since the district junctor and line link have been marked, it is now possible to operate the associated line link frame primary and secondary crossbar switch selecting magnets. When the subscriber's sender link controller completes its functions in selecting an idle sender link and sender, it signals the line link controller which proceeds to operate the holding magnet of the selected district junctor and, in turn, the holding magnet of the calling line. When these magnets operate, the crosspoints are closed, thus connecting the subscriber's line to the district junctor. The primary hold magnet also acts as a cut-off relay which causes the line relay to release as a signal to the controller circuits to release so as to handle other calls.

Miscellaneous Functions: The line link controller is arranged to shift its choice to another subgroup of 10 district junctors if the subscriber sender controller signals for a release because of failure to complete its functions.

Every call is timed during the functional period of the line link controller; thus, if for some reason a call encounters a trouble condition, after a period of a few seconds this call loses its preference and other waiting calls will be served by the line link controller of the mate frame.

If an originating call is delayed due to lack of equipment, a terminating call may release it, complete the terminating call, and then allow the originating call to again try to complete.

Terminating and originating calls will be alternately served by the line link frame.

Terminating Calls

When a terminating call is to be completed to a line on this line link frame, the terminating marker seizes the proper number group connector circuit and through it tests the sleeve of the called line. If the line is found idle, the marker records the information it receives from the number group connector circuit as to the line link frame number and the horizontal group containing the called line. Knowing the above information, the marker, through the line choice connector frame (after the completion of any originating call which may be in progress on this frame) obtains control of the line link frame and locks out other originating or terminating calls, momentarily. As soon as this is done, the line choice connector under control of the terminating marker will operate the horizontal group relay corresponding to the horizontal group in which the called line appears. The horizontal group relay gives the marker control over the ten line links in the particular horizontal group, and enables it to choose an idle line link over which to complete the call. Having chosen the combination of line link, line junctor, and incoming link to be used for the call, the marker operates the necessary selecting and holding magnets on the line link switches to connect the line over a line link to a line junctor. At the conclusion of these operations, the controller is released to permit it to handle other calls.

Where both originating and terminating calls are waiting for the use of the line link controller, originating and terminating calls will be served alternately.

DISTRICT JUNCTOR FRAME

PURPOSE

The district frame group includes the district junctor, district link, and subscriber sender link frames and is illustrated in Chapter 1, RM 1-12. The district junctor frame is mounted in the center of the group with the subscriber sender link on the left and the district link frame on the right. The district junctor frame mounts the equipment required for 100 district junctors. The subscriber sender link frame provides access for these district junctors to subscribers' senders, and the district link frame access to office junctors. The primary bays of these two link frames on which the district junctors appear are located immediately adjacent to the district junctor frame. The three frames are located together in order to facilitate maintenance and the wiring between them.

DESCRIPTION

The district junctor frame illustrated in RM 2-2 provides for 100 district junctors in five separate units of twenty circuits each. When the district junctors on a unit are arranged to time local calls, a timing device is located on each unit. Each unit mounts district junctors, providing the same class of service but units serving varying classes of service are located on the same frame. There are three types of district junctors in units of 20 or less each. These are coin, non-coin, and key-pulsing. The non-coin district junctors provide flat rate, message rate individual or 2-party service, with or without local timing or zone registration. Coin district junctors may be provided with or without local timing. Key-pulsing district junctors are for use by the key-pulsing "A" switchboard operator, and are always mounted at the top of the frame. This arrangement of units is due to the desirability of spreading the district junctors providing a particular class of service over as many frames as possible in order to minimize the effect on service in case a frame is made busy for maintenance reasons. The five units or "groups" of district junctors are divided into ten subgroups which number upward from 0 to 9. The junctors themselves alternate their count, within the subgroup, between the two bays; i.e., 0 left and 1 right, etc., to 8 left and 9 right, as shown in RM 2-2.

FUNCTIONS

As has been mentioned, the district junctor circuit is provided to furnish talking battery, to maintain supervision over the call during conversation, and to control the disconnection of the various paths at the end of the conversation. The district junctor is subject to selection by its associated sender link frame, and when selected, it immediately closes the tip and ring conductors from the calling subscriber through to the sender circuit which functions to furnish dial tone. The fundamental tip and ring leads are also closed through for the purpose of establishing the connection beyond the office link frame.

The district junctor records the information sent by the originating marker for charging purposes, and type of talking path required. If the call is of the operator class, the district junctor will close the subscriber's line straight through to the operator's trunk circuit; thus in this manner, the operator's cord circuit furnishes the talking battery and the operator obtains direct switchhook supervision as well as control over the connection. Other than operator's calls, the district junctor furnishes the talking battery with bridged impedance transmission.

Message rate (non-coin) district junctors are arranged to operate the line message register associated with the subscriber's line as soon as the proper charging time interval has elapsed after the called party has answered. In the case of two-party message rate lines the district junctor operates the proper message register from the information received from the marker, and it also checks that the two message register leads are not crossed, thus preventing false registrations. In conjunction with a local timing device located on the district junctor unit, it will charge the subscriber an additional time for each overtime period on overtime calls. The non-coin district junctors may also be arranged in conjunction with zone registration equipment to make additional charges on zone calls. Inasmuch as Cleveland will not be likely to have this equipment, this course will not cover it, other than to mention that they are available if required.

Coin district junctors are arranged to collect or refund a coin at the end of a conversation. To accomplish this, they require the assistance of a coin control circuit. This circuit is selected through a coin control link frame at the end of a conversation and the coin control circuit collects or refunds the coin as directed by the district junctor. Local timing may be furnished on coin district junctor units and, in this case, the coin control circuit is called in on the connection at the end of 4-1/2 minutes. The coin control circuit tests for and collects the deposited coin which serves as a signal to the calling subscriber that his call is due to terminate in 1/2 minute. If he chooses to continue the conversation, he deposits an additional coin during the remaining 1/2 minute interval, which causes the coin control circuit to disengage itself from the district junctor, and the conversation then continues undisturbed for another 4-1/2 minute period. Should the subscriber fail to deposit a coin during the 1/2 minute interval, the coin control circuit will route the call to an operator for disposition.

Key pulsing district junctors are furnished for the use of the DSA operator in setting up calls. These district junctors are furnished in a separate unit and only one is located on a given district junctor frame. This unit is not wired to the subscriber sender link frame since the district junctors do not require access to subscriber senders. Instead, they are cabled to the key pulsing sender link frame through which they obtain access to key pulsing senders. By means of her keyset, the DSA operator is then able to set up the required number in a key pulsing sender. This sender obtains access to an originating marker and the marker controls the setting up of the call to an outgoing trunk in the usual way.

The district junctor circuit is arranged to automatically release the connection after a time interval in case the called party has answered and the talking time was long enough to set up a charge condition; then the called party disconnects, but the calling party fails to disconnect.

If, for any reason, the originating marker can not establish the connection to the outgoing trunk, the marker will cause the district junctor to release the information it had previously given to it. The marker will also release and allow the sender to make a second trial as though it were a new connection.

Since all junctors on this frame are served by the same subscriber's sender link frame and the associated district link frame, only one call at a time may be served. However, this is only true while in the act of connecting to a sender, and when functioning with an originating marker, the time interval being very short in these periods.

Twenty district frame groups constitute the capacity installation of a crossbar office.

DISTRICT JUNCTOR DISTRIBUTION

The number of calls which can be served by a given line link frame is about 1000 ccs. (equivalent hundred second calls). Assuming for purposes of illustration that one—half of the traffic on a given line link frame is originating, therefore 500 ccs. will be delivered to the 100 district junctors. Traffic figures show that 100 district junctors will care for 2500 ccs. It is evident that in order to load the district junctors fully, it will be necessary to multiple them to other line link frames requiring access to district junctors offering the same class of service. If the other line link frames to which the district junctors are multipled also deliver approximately 500 ccs. of originating traffic each, the district junctors can be multipled five times.

The multipling of district junctors is done in each office in accordance with a pre-determined pattern which must be revised to fit the requirements of each particular job. A portion of this multipling is done directly at the line link secondary switches by means of cabling, but in order to provide a ready means for changing the multiple to take care of changes in the originating traffic, some of this switch cabling is extended to a "district junctor grouping frame" where the groups are combined. At the district junctor grouping frame rearrangements can be made with less expense and interference to service than would be possible if this work were done directly at the line link frame secondary switches.

RM 106 shows a typical cabling schematic which may be helpful in following the description. The district junctor circuits are cabled in groups of 20 from the district junctor frame to the horizontal side of the district junctor grouping frame where they are combined with control leads of the associated subscriber sender link and distributed to various combinations of line link secondary switches. These miscellaneous control leads include class of service leads and the control leads between the line link and sender link used in the choice of the district junctor on originating calls; therefore, on whatever line link frame the corresponding district junctor appears, these control leads must also appear.√

The vertical side of the district junctor grouping frame terminates the cables from the line link secondary switches either as "single" or combination" appearances. These are cross-connected by means of jumper cables to the district junctor groups on the horizontal side.

The number of line link frames to which the various groups of district junctors will be multipled will depend on the amount of originating traffic delivered to the district junctors by the line links on the various line link frames. The example quoted previously showed the originating equalling the terminating traffic and required the district junctors to be multipled five times. Where the originating traffic exceeds the terminating it will not be necessary to multiple as many as five times in order to obtain the necessary 2500 ccs. for each district link frame. Where the terminating exceeds the originating, the district junctors should be multipled more than five times. In actual practice all district junctor groups are not multipled the same number of times; RM 107 is an illustration of this in that some groups of district junctors are multipled five times and some six times.

As may be seen on RM 108, the 100 district junctors from a given line link frame are not multipled intact nor do they go to only one district frame. District junctors are multipled in groups of twenty and the 100 from one line link are carried as far as possible to five different district frames. In addition, the district junctors appearing on one district link frame are scattered in groups of twenty as far as possible over the various line link frames in the office.

The spreading of the district junctors from line link frames to as many district link frames as possible (five if practicable) is for the purpose of minimizing the effect on a line link frame of a trouble condition affecting the whole of a district link or subscriber sender link frame. Using this spread (5 frames) only 20% of the district junctors serving a given line link frame would be out of service. RM 108 illustrates a typical example of the distribution of district junctors from line link frame to district frames. √

The spreading of district junctors associated with a given district link frame over as many line link frames as possible is desirable from the point of view of spreading the originating traffic evenly over the district link frames. No two line link frames will deliver exactly the same proportion of the originating traffic of the office and this spread of the district junctor groups tends to equalize the originating traffic delivered to the district link frames. In line with this objective it is also desirable that succeeding line link frames shall reach different combinations of five district link frames. RM 107 illustrates the distribution of district junctors from district frames to line link frames. This is part of the same typical pattern illustrated on RM 108.

The line link control circuit is arranged to assign originating traffic to the district junctors on secondary switches in accordance with an order determined by the district junctor preference cross-connections. Initially in any office this order will give secondary switches 0 and 2 first preference, switches 1 and 3 second preference followed in order by switches 4 to 9. With this the case, each group of 20 district junctors as far as possible should appear on a different pair of secondary switches in the succeeding line link frames which it serves. In addition there should be a transposition of the two subgroups of 10 district junctors forming each group of 20 between their appearance on a pair of secondary switches on one line link frame and their appearance on the next higher numbered pair of switches on the succeeding line link frame they serve. The term "transposition" indicates that the two subgroups of 10 district junctors in a group of 20 shall be transposed with respect to each other, but with no change in the order of the individual circuits in each subgroup of 10. This reversal is made necessary by the method of assigning originating traffic employed by the line link control circuit and tends to equalize the traffic to the pair of district link primary switches with which the group of 20 district junctors is associated.

District serving line link secondary switches 0 and 1 on a given line link frame should be located on an even numbered district frame, and those serving secondary switches 2 and 3 on an odd numbered district frame, or vice versa. This requirement, together with the circuit operation referred to in the preceding paragraph, insures the assignment of a different channel to a different outgoing trunk on a second subscriber's attempt during a light load period.

Where the number of line link frames for a particular class of service is small, the multipling arrangements discussed above can not be carried out in full.

As stated previously, the distribution of district junctors is done by a definite pattern which is made to fit the office. This is more of a traffic and engineering problem than a plant function; however, it was decided to include this description so that the student might see more readily some of the reasons behind the distribution.

SUBSCRIBERS' SENDFR LINK AND CONTROLLER

PURPOSE

This frame provides for facilities to connect any one of its associated 100 district junctors to any one of 100 or less subscribers' senders, thus completing a path from the calling subscriber's line to the district junctor and thence through subscriber's sender link frame to a subscriber sender so that the calling subscriber may be notified to place his call. Since this frame must operate before the subscriber begins to dial and before the originating marker has been connected, it must be provided with a control circuit. This control circuit assists the line link controller in choosing the particular district junctor to be used on the call and also determines which sender is available.

DESCRIPTION

RM 2-3 illustrates the assembly of a subscriber sender link frame. The right hand or primary bay mounts ten 200 point 4 wire crossbar switches. Since there are eight leads per district junctor to be connected to the sender, each district junctor requires two verticals on the primary switches. The verticals on the left hand of switches 0 and 1 are connected to the 10 district junctors of subgroup 0 and are designated 0A and 0B respectively. The right half of these switches are associated with district junctor subgroup 1, and are designated 1A and 1B respectively, etc.

When the sender link frame is associated with a district junctor frame on which is mounted a group of 20 key pulsing district junctors, the top two primary switches are not required, and therefore, they are not equipped. Selection of key pulse senders used with key pulse district junctors is done by another frame known as a "key pulsing sender link frame."

The left hand or secondary bay mounts five 200 point 4 wire switches, together with the controller equipment. The subscribers' senders are connected to the horizontals of these switches. Since each sender requires eight leads and there are only five switches, the maximum number of senders available would be 25. However, since the average number of senders in an office is approximately 100, and since a group of 100 senders is more efficient than four groups of 25 senders the horizontal strapping is split into four sections of five verticals each. This results in having 200 terminations on the horizontals required by 100 senders.

Subscriber senders are cabled to the subscriber sender link frame secondary switches in groups of ten and multipled to other subscribers' sender link frames; the primary appearance being on a different frame for each subgroup of 10 senders. The effect of this method of cabling is to minimize the possibility of a complete failure in case of damage to the sender multiple on any one sender link frame. RM 2-4

Where the number of senders exceeds 100, each sender subgroup is multipled through as many sender link frames as required to provide, as far as possible, an equivalent number of appearances for each sender subgroup.

Where the number of senders is less than 100, groups of ten senders are cabled to as many secondary switches as possible on each sender link frame. Since the number of senders is seldom a multiple of 10, the odd number of senders is assigned to the last switch on the frame. However, this practice is modified by requiring that there be at least three subgroups of five senders each. The unequipped sender subgroups are then cabled to equipped subgroups on the same frame so that all links may reach all senders.

The verticals in the first and third quarters of each secondary switch are associated with a subgroup of 10 senders which appear on the associated horizontal levels. The verticals of the second and fourth quarters of each switch are associated with another subgroup of 10 senders. The sender subgroups count upward in two counts 0C-0D to 4C-4D and 5C-5D to 9C-9D, as shown on RM 2-3. The reason for using alternate sections of the switch is that when there are less than 100 senders, the number of sender subgroups may be varied by connecting sections with strapping rather than by multiple cables. In this manner, the number of subgroups may be reduced to five, multiple cables being used for less than five subgroups.

The subscriber sender link frame links use the standard horizontal to vertical spread between the primary and secondary switches. The arrangement of the sender links is shown on RM 109 and 110. Since there are 100 horizontals on the primary switches and two horizontals must be used for each sender link, there is a capacity for only fifty links. However, since the holding time of sender links is considerably less than 1/2 of that of district junctors, the ratio of 50 links to 100 district junctors is satisfactory. These fifty links require 100 verticals on the secondary switches which are furnished by the five 200 point switches.

One emergency sender link controller circuit is provided to which any sender link can be connected by means of manual switches when the normal controller circuit fails. Four switches are provided on each sender link frame, two of which represent the normal controller and the other two the emergency controller. Pilot lamps are provided in each sender link frame to indicate when the emergency controller is in use by that link frame or by another frame. The emergency controller is mounted on the miscellaneous relay rack and is equipped with pilot lamps to indicate which subscriber sender link frame, if any, is connected to it. When transferring a sender link frame from its normal controller to the emergency controller, the two multi-contact switches associated with the normal controller should be restored to normal before the pair of switches associated with the emergency controller are operated in order to prevent interference.

Ten multi-contact relays are furnished on each sender link frame, one for each sender subgroup, for the purpose of connecting the control leads from the line link frame to the sender which has been chosen.

FUNCTIONS

The subscriber sender link frame, like the line link frame, handles one originating call at a time in establishing a connection of a subscriber's line to a district junctor and to a subscriber's sender. It is provided with a controller whose function is to choose an idle sender and to notify the line link frame as to which district junctor group has clear access through sender links to an idle sender.

Each group of 20 districts junctor has access to ten sender links. It is obvious that a group of district junctors which does not have access through an idle sender link to an idle sender should not be chosen to handle the call. The line link controller indicates to the subscriber sender link controller in which group of ten district junctors it can place a call and if this group has at least two idle district junctors with an idle sender link to an idle sender, the line link controller will be signalled to use this district junctor group. The line link controller failing to get this signal will attempt to place its call through other district junctor subgroups and due to the distribution of district junctors, other subscriber sender link frames. The line link controller having tested all available district junctor subgroups and not finding one, will, after a slight delay, employ its reserve test and attempt to choose a district junctor subgroup having one idle district junctor with access to an idle sender link and sender. RM 2-7 or 105 may be helpful in tracing the call through the line link, district junctor, and sender link frame to a sender.

The sender link controller will next simultaneously test the ten subscribers' sender subgroup to determine which subgroups have two or more idle senders with an idle sender link to the chosen district junctor subgroup. After a slight pause, if none are available with two or more, it will again retest to select one with one idle sender. In either case, the controller will select the sender subgroup preferred by the district junctor subgroup if possible; otherwise, it will shift the preference to another sender subgroup.

The choice of a particular district junctor and of a particular sender in their respective subgroups is controlled by cross-connections from DP punching to punchings DO-1-2-3 or 4 of Fig. 8 and cross-connections from SP punching to punchings PO-2-4-6 or 8 of Fig. 9. This method of choosing a particular district and sender is to distribute wear over the equipment. However, if the preferred circuit is busy, the preference is shifted to another circuit. See SD-25554-01.

Control leads cut through to the sender subgroup by the multi-contact relay include the class of service leads from the line link frame which operate the proper class of service relay in the sender. In addition, a frame number indication is given through the connector relay to the sender so that the marker may be able to recognize which district frame group contains the calling district junctor.

The sender subgroup, when seized, is held busy until the sender has been chosen and the class of service and district junctor frame number has been recorded in the sender, which takes place at the moment the sender is seized.

After the sender has been selected, the proper selecting magnets of the crossbar switches are operated followed by the holding magnets. The line link controller is then signalled to close its crosspoints. Continuity test to the calling station from the sender is now made; and if an open occurs during the test, a release signal is given to the line link controller. While this test is being made, the sender link controller tests to ascertain whether the subscriber sender link switches operated falsely due to a cross or a double connection; if so, the subscriber sender link controller would block and release from the connection.

When the primary holding magnet on the line link frame operated the subscriber line relay releases. This signals the sender that the crosspoints have been closed. The sender link controller then signals the sender to take control and hold the established connection, and if the above-mentioned tests are successful, the sender notifies the subscriber sender controller that it has control of the connection. The subscriber sender controller then notifies the line link controller, which checks the established connection through the subscriber sender controller and its switch crosspoints, district junctor lead and through its own switch crosspoints and if successful the line controller will release and signal the subscriber sender controller to release, leaving the sender in charge of maintaining the connection.

When the sender has completed its functions, the sender will notify the district junctor to control the established connection and will release the subscriber sender link primary and secondary holding magnets since they are no longer needed.

MAIN DISTRIBUTING FRAME RM 2-5

The main distributing frame (MDF) for crossbar offices do not have directory numbers appearing on the horizontal side as in panel offices. Instead there are equipment numbers corresponding to the column, switch and vertical of the line link frames.

Cabled to the horizontal side are the tip and ring leads from the line link vertical and hold magnet equipment. They appear in groups of 100, as per column and in numerical sequence of the line link frames.

Each column of 100 lines are terminated in two blocks of fifty and are designated 00 to 99. At the end of the first block of each pair is the office designation and the associated column number.

A two wire cross-connection is laid in between the tip and ring on the vertical side (underground cable) and the tip and ring on the horizontal side (line equipment number) assigned to the subscribers directory number.

LINE DISTRIBUTING FRAME

The line distributing frame (LDF) is a single sided cross-connecting frame having terminal strips mounted horizontally in the upper part and vertically in the lower part. It is arranged for the cross-connection of two leads (S and M1) per subscriber line equipment.

Cabled to the horizontal strips are the S and M1 leads from the line link vertical and hold magnet equipment, in groups of 100 as per column and in numerical sequence of the line link frames.

Each column of 100 are terminated in four blocks of 25 each and are designated 00 to 99 within each quad. Within each group of 100 is the associated column number.

Cabled to the vertical strips are the sleeve leads (S) from the block relay frames and the message register leads (M) from the message register cabinet. These leads are brought together and arranged in numerical order according to directory numbers.

One vertical strip of four terminal blocks accommodates 200 directory numbers. Each pair of terminal blocks are designated 00 to 99, in the middle of which is the thousands and hundreds digit of the 100 associated directory numbers.

A two wire cross-connection is laid in between the directory number and the line equipment number assigned to the subscribers line. Other cross-connection arrangements are associated with the LDF but being explained at this time would serve no useful purpose. These cross-connections are included in the study of the terminating marker.

Directory numbers (subscriber lines) may be assigned to any line link frame verticals which are arranged for the proper class of service without regard to numerical order. They are assigned to the verticals in such a manner as to distribute the lines as evenly as possible to balance the traffic load.

DESCRIPTION OF LINE EQUIPMENT NUMBER

For the convenience of locating the line equipment number associated with a particular directory number, a plan has been devised for this purpose and is known as the "Subscriber Line Equipment Record."

Tabulated in this record is the numerical sequence of all line equipment in the office. As the line equipment is connected to or disconnected from the assigned directory number, the directory number is recorded or removed respectively from the associated line equipment number.

The line equipment number represents an individual line link primary switch vertical and its location within its associated equipment.

For the purpose of this numbering system, the columns are numbered consecutively throughout the line link frames. The column numbering starts with the two digits, zero-zero and runs into three digits on certain jobs in Manhattan Area.

The line equipment number has five divisions. As for example; equipment number 7C6093 relates the following:

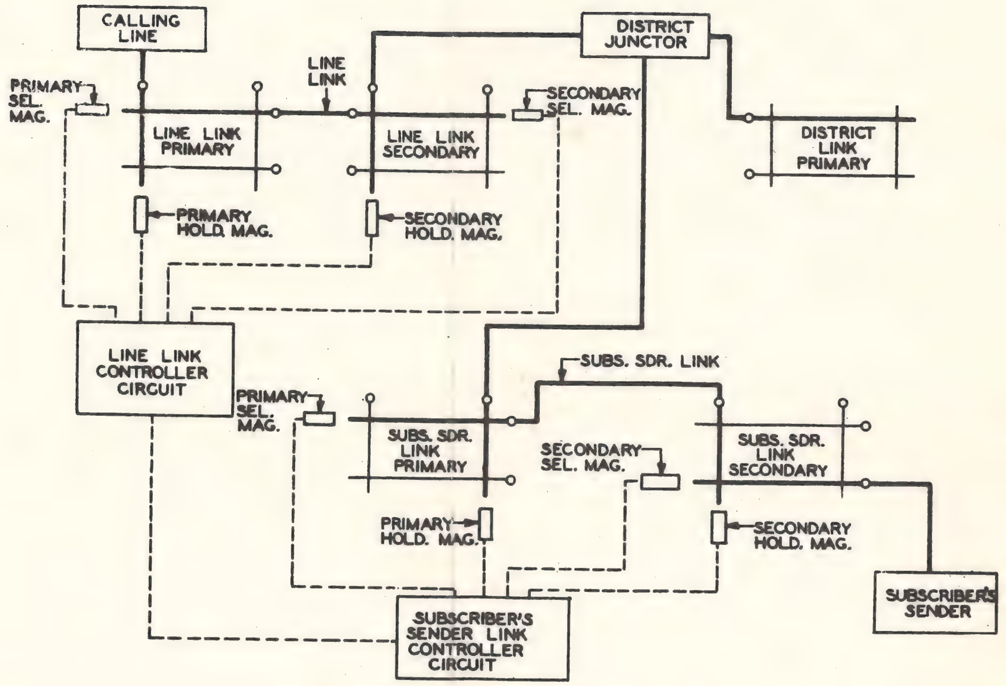
1. 7 Line Choice
2. C Line Link Frame
3. 60 Column
4. 9 Switch
5. 3 Vertical

The first division "Line Choice" can number from 0 to 19 depending upon the amount of line link frames in the office. Each consecutive four line link frames constitutes a line choice. Zero to three frames being line choice #0, four to seven line choice #1, etc.

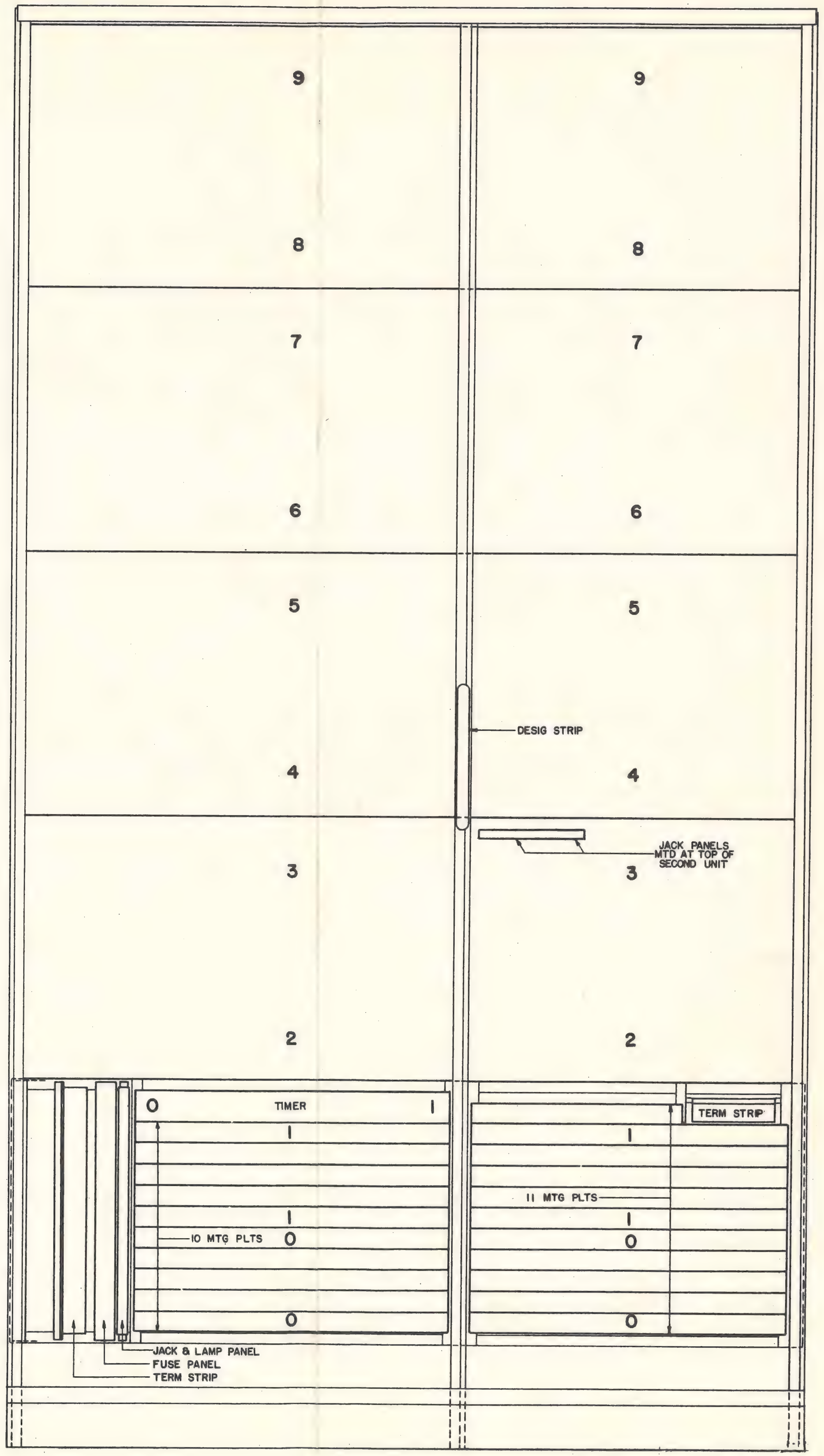
The second division "Line Link Frame" will be designated consecutively and limited to A, B, C and D indicating the line link frame location within the line choice. For future purposes this will also be called the quarter choice.

The third division "Column" starts from #00 and runs consecutively to #111 for the largest office at present in Manhattan Area. This might be expanded greatly, if required in the future, since the total of 20 line choices constitutes 80 line link frames.

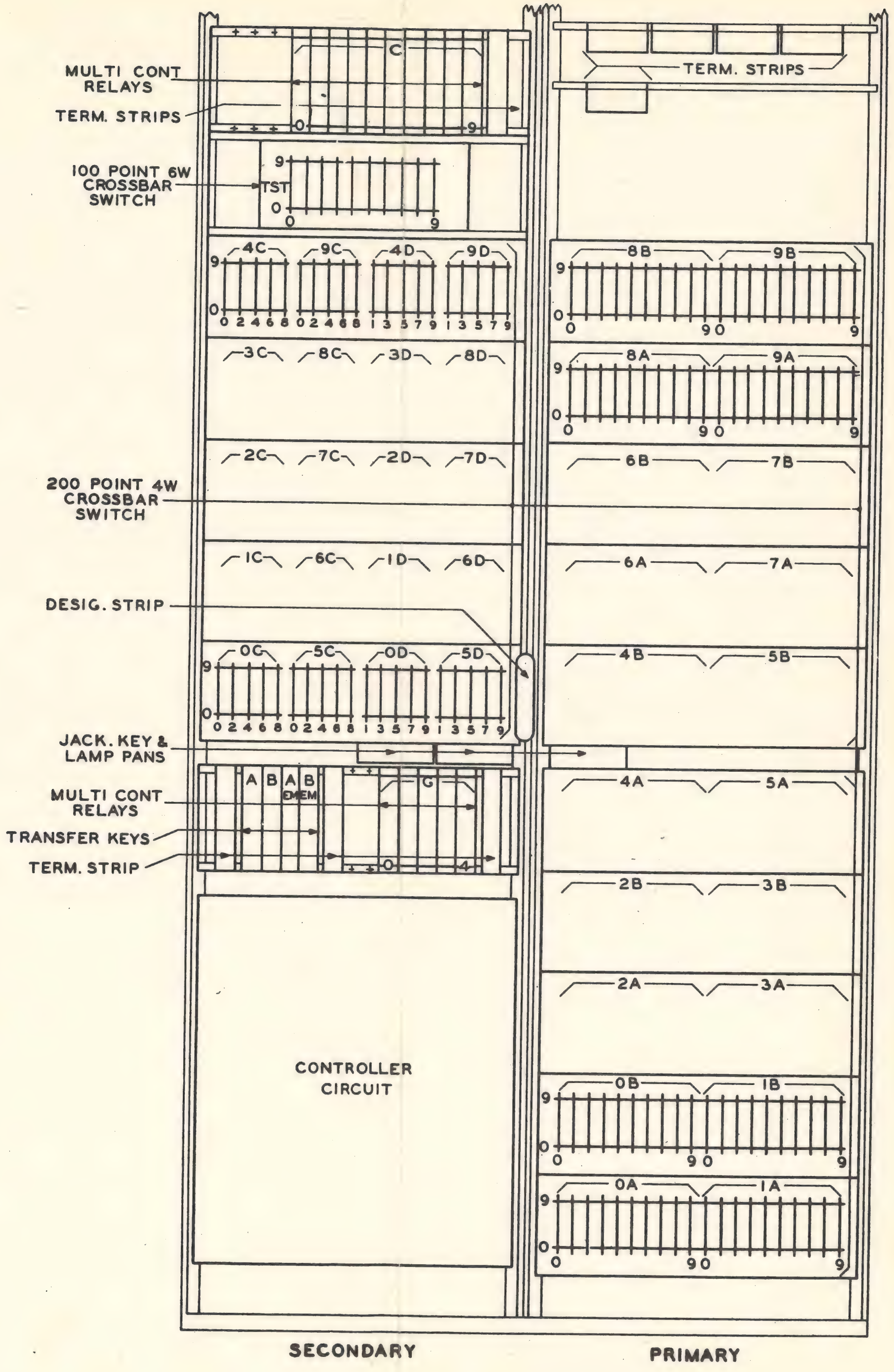
The fourth division "Switch" is limited to #0 to #9, this being the total number of line link primary switches in a bay and serves to indicate the switch in which the vertical is located.



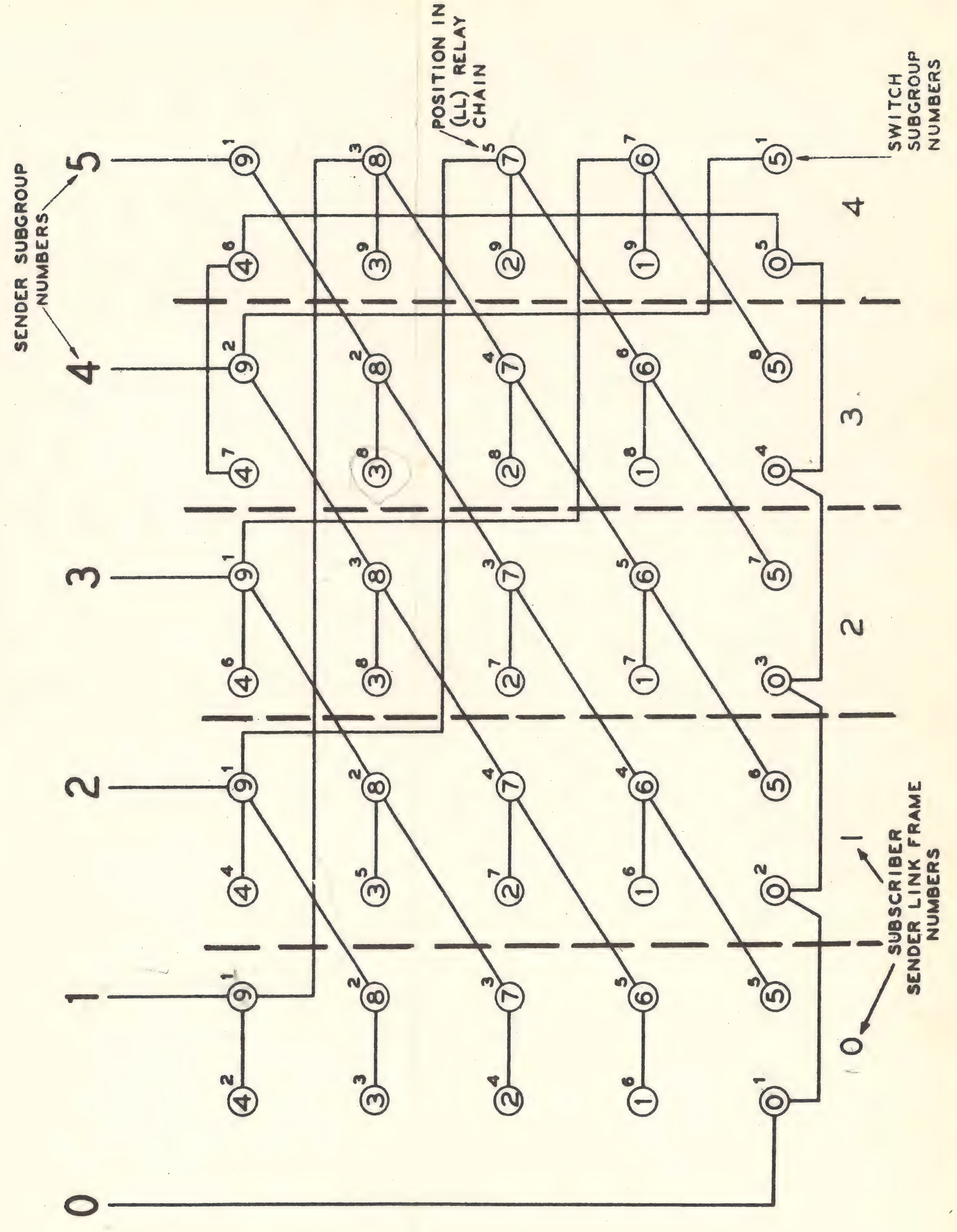
Calling Line Connected To
Subscriber Sender



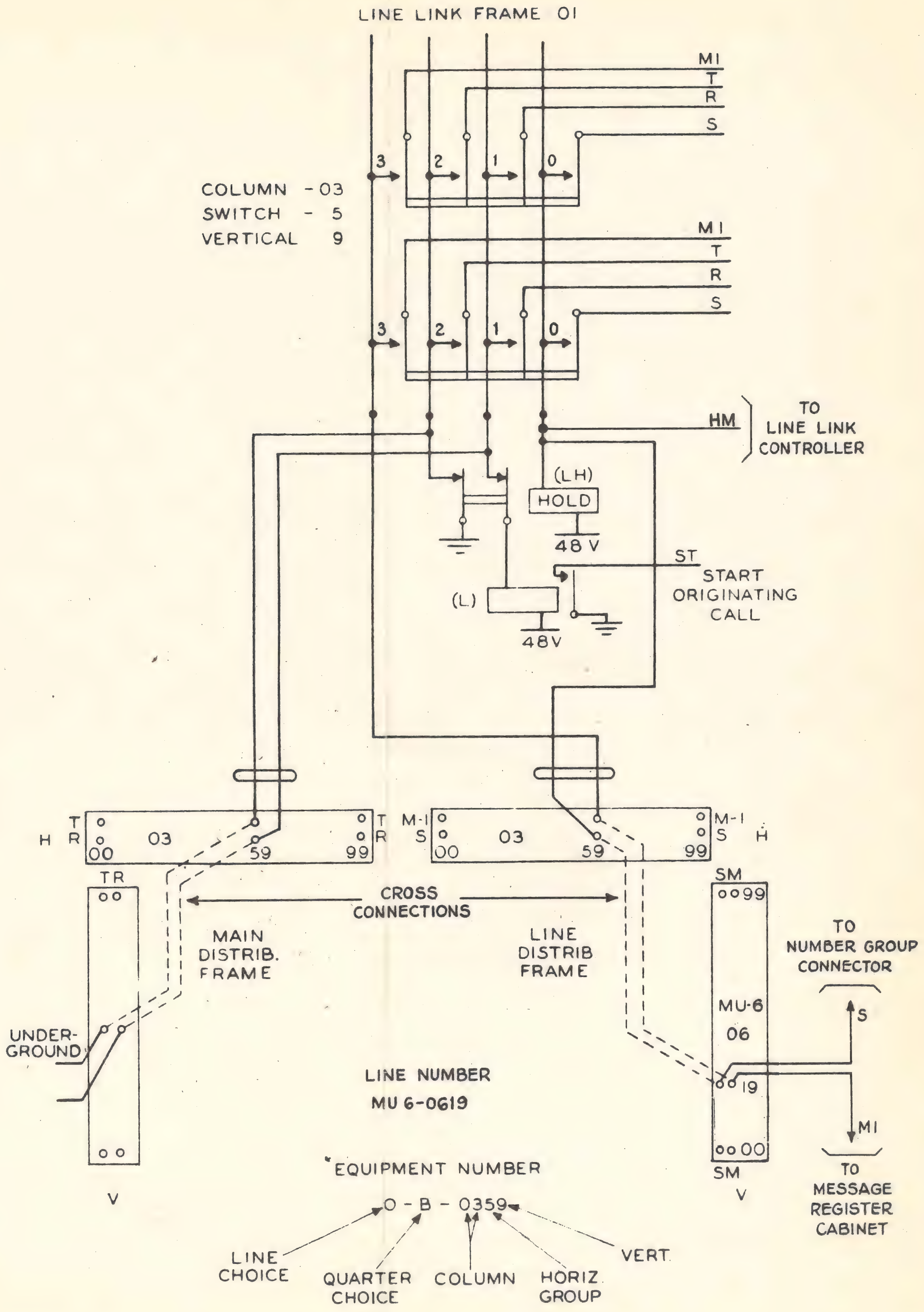
DISTRICT JUNCTOR FRAME



SUBSCRIBER SENDER
LINK FRAME


SENDER SUBGROUP NUMBERS
POSITION IN (LL) RELAY CHAIN
SWITCH SUBGROUP NUMBERS
SUBSCRIBER SENDER LINK FRAME NUMBERS
0
1
2
3
4
5
0
1
2
3
4

SUBSCRIBER SENDER LINK FRAME
SENDER MULTIPLE



MDF, LDF AND LINE VERTICAL

CHAPTER 2

SECTION 2

METHOD OF OPERATION

MARCH 1954

METHOD OF OPERATION

GENERAL

This section is devoted to detailed circuit operation of the Line Link, Subscriber Sender Link and Controllers with associated circuits.

SEIZURE OF CONTROLLER CIRCUIT BY LINE CIRCUIT OS 101-1, 102-1

When the calling subscriber's receiver is removed from the switchhook, the line relay is operated as in other systems. Before the subscriber can proceed to dial the required number, however, he must be connected to a sender from which he must receive dial tone.

When the subscriber removes the receiver from the hook, a circuit is closed over the tip and ring to operate the (L) or line relay associated with column, switch and vertical. The operation of the (L) relay grounds the start lead to the controller circuit. Start leads are common to the ten (L) relays located in the same horizontal group and in the same column. The (L) relay in operating also grounds the "LT" (Line Test) lead. "LT" leads are individual to each (L) relay. The function of the "LT" leads will be covered in line test.

The ground on "STA-" lead operates the (HA-) relay and ground on "STB-" lead operates the (HB-) relay. There are ten (HA) relays and ten (HB) relays, their numbers 0 to 9 correspond to their associated horizontal group: that is, calls originated in horizontal group 5 operate the (HA5) and (HB5) relays, likewise calls in horizontal group 9 operate (HA9) and (HB9) relays. In all cases the horizontal group number and the (HA) or (HB) relay number will be the same.

HOME CONTROLLER CIRCUIT SELECTED OS 102-1

The (HA-) relay in operating, locks and operates the (CA) relay. The function of the (CA) relay in conjunction with the (CB) relay is to determine whether the home or mate controller circuit is to be used. Generally the adjacent line link frame's controller circuit is used for emergency operation and it is called mate frame. In the event of controller trouble on the frame where the calling line is located, the mate controller circuit attempts to establish the connection. These two controller circuits, working in conjunction with each other, are called Home and Mate Controller circuits. The (CA) relay being faster in operating than the (CB) relay, causes the home controller circuit to be preferred. If for any reason the (CA) relay is delayed in operating, the (CB) relay will operate under control of the (HB) relay which functions in parallel with an (HA) relay.

MATE CONTROLLER CIRCUIT LOCKED OUT OS 102-1

The (CA) relay in operating operates relay (FA).

Relay (FA) on the home frame and relay (FB) on the mate frame are arranged in a chain circuit so that both frames cannot seize the same controller circuit at the same time. When a frame is using the mate controller circuit, its

(FB) relay will be operated. The operating path of the home frame (FA) relay is through a normal contact of the (FB) relay on its mate frame. This is done to be sure the home controller circuit is not in use serving the mate frame.

TIMING STARTS

On the operation of relay (CA) relay (TA) operates awaiting (IA) interrupter. If the "ST" lead ground is not opened within 6 to 12 seconds, the timing circuit functions to transfer the call to the mate controller circuit. This circuit action is covered under Alarm and Transfer Timing Circuit OS 123-1.

CUTTING IN LEADS TO THE HOME CONTROLLER CIRCUIT OS 102-1

The (FA) relay in operating, locks and operates the (AC) and (HC-0 to 3) relays.

The (AC) and (HC-0 to 3) operate if the home control circuit has returned to normal from the previous call which is indicated by the normal (RL) relay. These relays are known as connector relays and connect various leads of the frame to the home controller circuit. They lock under control of relay (FA). In the event that the mate controller circuit is to be used, relays (BC) and (MC-0 to 3) will operate.

HORIZONTAL GROUP SELECTION OS 103-1

(HC1) relay in operating, locks lowest number (HA) relay operated. The (AC) relay in operating operates the (GTA) relay.

The operation of the (GTA) relay opens the operating circuit to all (HA) relays. If a number of subscribers in different horizontal groups had originated calls before the (GTA) relay had operated, their corresponding (HA) relay would be operated. However, the (HA) relays which were operated, lock under control of the subscriber's line in their corresponding groups.

The purpose of this feature is to permit the serving of those subscribers whose (HA) relay is locked up before other subscribers in other groups who might have originated a call after the (GTA) relay is operated. The (CA) and (GTA) relays remain operated between the setting up of these calls, until one call in each horizontal group associated with (HA) relays operated, has been served.

The (GTA) relay in operating, operates the (HG-) relay.

The lowest numbered operated (HA) relay has preference and its (HG) relay operates. There are ten (HG) relays, one for each horizontal group. These relays cut through, in part, the various leads to their particular switch.

VERTICAL GROUP OR COLUMN SELECTION OS 104-1

Relay (SR) was operated by relay (HC1). (No function at this time.)

The (HG-) relay in operating, operates the (V) relays. All the (V) relays operate on every call.

There is a (V) relay for each column on the frame. The maximum number of (V) relays is seven. The purpose of the (V) relays is to recognize the column in the horizontal group in which the calling line is located. The (V) relays lock to the "ST" ground. Any (V) relay will operate the (TT) relay. A chain circuit through all (V) relays operated, operates the (VT) relay after relay (TT) is operated. The continuity of all the "ST" and "VG" leads is checked by the (VT) relay operating through the operated (V) relays. (Note: The number of (V) relays furnished on a frame is the same as the number of columns on the frame or its mate frame.)
The (TT) relay cuts through, in part, the operating path for (G) relays 0 to 4.
" (VT) " " " " " " " " " " " 5 to 9.
" (G) relays will be covered later. OS 108-1.

The (VT) relay locks and operates the (H-) relay.
The (VT) relay also removes one shunt from (S) relay. (S) relay is shunted by "ST" ground. This is a check for a false ground on the "ST" lead after the operation of the (H-) relay.

The (H-) operated removes the last shunt from relay (S) and it operates in series with (HA-) locked.

Relay (H-) in operating separates the seven "VG" and "ST" leads leaving only those leads grounded in the columns where there are calls awaiting. This releases all (V) relays except those whose "ST" lead is grounded in the horizontal group.

The separation of the start leads also removes the shunt from the (VS) relay (vertical selected) and it operates in series with the (VT) relay which locks. Relay (HB-) is also released at this time.

The (VS) relay operates the (VE) relay (Vertical End).

The (VE) relay operated, operates the (LR) and (HM) relay. The lowest operated (V) relay has preference. *Example: (V3) relay is operated, the (LR) and (HM) relays, associated with column 03 and switch 5 operates. (HG5 relay determines the switch.) The (VE) relay also opens the operating path for all (V) relays preventing any more from operating during the progress of this call. *SD-25003-01.

On the newer type installations (SD-25553-01) the circuit has been designed to alternate the direction of preference of groups of ten lines in a horizontal line group for successive calls.

In order to insure all subscribers originating calls being served even when a line group of normal lower preference is in trouble, the circuit is arranged to alternately reverse the direction of the preference on the (V-) relays on successive calls.

For relays (V-0) to (V-6) the (VP) relay determines the direction of preference in its operated or released position to select the (V-) relay holding and (VE) relay operating chain and the "VS" lead chain starting at relay (V-6) when operated and at relay (V-0) when released.

Relay (VP) releases when relay (LP) operates.

Relay (VP) released with relay (PR) operated or relay (VP) operated with relay (PR) released closes a locking ground to relay (RL) to check the operation or release of relay (RP) after every call. OS 105-1.

LINE SELECTION OS 105-1

The (LR-) relay in operating, extends the "LT" leads of that column and switch into the controller circuit and they become "LR" leads. Any of the ten (L) relays 0 to 9 that are operated in that column and switch will operate its associated (LT) relay. There are ten (LT) relays designated 0 to 9. (L9) relay operated, operates the (LT9) relay, as an example.

The (HM-) relay in operating extends the "HM" leads of that column and switch into the controller circuit to the contacts of their associated (LT) relays. A chain circuit is closed through the lowest operated (LT) relay over the "HM" lead to the line hold magnet, associated with this (LT) relay. Ground is not applied to the line hold magnet at this time. With this circuit action, the selection of a particular line is complete. The (L) relay operates its associated (LT) relay and the (LT) relay steers the circuit back to the associated (L) relay's line hold magnet with the aid of relays (HM) and (LR).

A chain circuit is also closed through the lowest numbered normal (LT) relays to the operated (LT9) relay to operate (RE) relay.

The (LT) relay also grounds a class of service punching.

The (RE) relay operates the (LS) relay from the "LT" lead ground.

Relay (LS) locks lowest operated (LT) relay to the (VE) relay. (LT-) locks through chain circuit. Relay (LS) also locks up to the same ground and operates (LE) relay.

The (LE) relay in operating, opens the operating path of the (LT) relays preventing others from operating. In the event several (LT) relays are operated, only the lowest numbered (LT) relay is locked up and the higher numbered (LT) relays release. SD-25003-01.

In the event of a line (L) relay operating only enough to close the "ST" lead but not its "LT" lead, none of the relays (LT-0) to (LT-9) or (RE) will be operated. This is generally a case of a subscriber's wet line where there is only sufficient current flow to operate the (L) relay partially. When relay (SR) releases following district selection a circuit is closed to operate relay (LS) which in turn operates relay (AP) to light the (AL) lamp and sound the minor alarm. The controller circuit will then be released in this case. This feature is covered in detail under "Release for a Partially Operated (L) Relay LL." (AP) relay also shown on OS 123-1.

On the newer type installations (SD-25553-01) the circuit has been designed to alternate the direction of preference of the lines in a selected group of ten lines being served on successive calls.

The (LP) and (VP) relays have been installed to care for a condition that could exist due to a trouble where the (L) relay does not operate fully preventing the "LT" lead from being grounded or trouble due to an open "LT" lead.

The operation or release of the (RP) relay will cause the (LP) relay to be released or operated.

The (LP) relay will change the preference of the (LT-) relays preventing a possible slow dial tone condition of other lines due to a partially operated (L-) relay or open "LT" lead.

In order to insure all subscribers originating calls being served even when a line of lower normal preference is in trouble, the circuit is arranged to alternately reverse the direction of preference on the (LT-) relay chains in successive calls.

For relays (LT-), relay (LP) determines the direction of preference in its released or operated position, in the former case by allowing the contact chains on the (LT-) relays to prefer the lowest numbered operated (LT-) relay and in the latter case by opening the normal individual battery supplies to relays (LT-0 to LT-8) and permitting only the highest one desiring to operate to receive battery over the back contact chain through the higher numbered from relay (LT-9). Under these latter conditions the operation of the highest numbered (LT-) relay prevents the operation of any lowered numbered one.

Relay (LP) operates from the operated (RP) relay. Relay (RP) will be operated or released on every call.

TESTING FOR BUSY LINKS OS 107-1

A busy link is indicated by ground on the sleeve.

When the (HG-) relay operated as a result of horizontal group selection, relays (T0) to (T9) were connected to the sleeves of the ten line links of the primary switch in that horizontal group. The (T) relays corresponding to busy links operate under this condition to the busy ground placed on the sleeve lead by the district junctor or incoming trunk circuit. Assuming all links idle, no (T) relays operate.

DISTRICT JUNCTOR DISTRIBUTION RM 106, 108

The district junctor grouping frame provides a means for connecting the line link frame secondary switches or district junctors to the district junctor frame, district junctor circuits and the subscriber's sender link controller circuit.

One hundred district junctors appear on the ten secondary switches of the line link frame. These ten switches of junctors are divided into five groups of twenty junctors each. Each group of twenty junctors are divided into two groups called A and B. The 100 district junctors from a line link frame are not multipled intact, nor do they go to only one district frame. District junctors are multipled in groups of twenty and the five groups of twenty each from one line link frame are carried as far as possible to five different district frames. RM 108. The spreading of the district junctors from the line link frame to as many district link frames as possible is for the purpose of minimizing the effect on a line link frame in the event of a trouble condition affecting the whole of a district link or subscriber sender link frame.

The number of line link frames to which the various groups of district junctors will be multipled will depend on the amount of originating traffic delivered to the district junctors by the line links on the various line link frames. RM 106 shows a district group multipled five times. The spreading of district junctors over as many line link frames as possible is desirable from the point of view of distributing the originating traffic evenly over the district frames.

The multipling of district junctors is done for each office in accordance with a predetermined pattern which must be revised to fit the requirements of each particular job. The district junctor grouping frame provides a means for this multipling process. The leads from the line link frame not only include those from the crossbar switch, such as the "R", "T", "S", "M1", and "M2", but various leads from the line link frame controller circuit to the subscriber's sender link controller circuit. RM 106, 108 shows the cable from the line link secondary switch to the Vertical of the district junctor grouping frame.

Note that some line link frames do not have direct cables to the DJGF but loop to adjacent line link frames. Jumper cables on the DJGF connect the vertical side to the horizontal side, which is associated with a district frame and group. These jumper cables are sometimes reversed. As a result of the reversal the higher numbered group on the district frame will appear on the lower numbered switch on the line link frame. Designation chart on the line link frame, switches 6 and 7 shows an example of this. The reason for this is: calls are always served to the A group on the line link frame first. By reversing the groups and having a B group of district junctors appearing in the A group position in the line link frame, the B group of district junctors will be served first. This distributes the wear on the equipment as well as distributes calls over the odd as well as even numbered switches in the district.

SUBSCRIBER SENDER LINK CONTROLLER, BUSY TEST OF LINKS AND SENDERS OS 106-1

The subscriber's sender link frame is provided with a controller circuit whose function is to choose an idle sender and to notify the line link frame that the district group has access, through the sender links, to an idle sender. Each group of 20 junctors has access to ten sender links. An idle sender link is indicated by ground on the "PA" lead from the normal (D) hold magnet. Ten sender groups appear on the ten secondary switches of the SSL. Sender group multiple will be covered under sender group selection. A sender group consists of ten senders. Associated with each sender is an (SB) relay which is part of the sender selector circuit. If the sender is busy in service or made busy, its associated (SB) relay will be operated. If all ten senders in the group are busy, the sender selector circuit (SGB) relay will operate by ground supplied from a chain circuit through all the operated (SB) relays. The (SGB) relay operates an associated (GB) relay in the SSL controller circuit. If there are no links available, ground will be removed from the "PA" leads 0 to 9 by the operated (D) hold magnets. If all sender groups are busy, the "PA" lead will be opened at the operated SSL (GB) relays.

DISTRICT GROUP, BUSY TEST OS ~~104-1~~ 106-1

If a group of twenty junctors on a district junctor frame are made busy, its "PA" lead is opened at the operated "MB" jack. If the group of junctors are busy, its associated (DP) relay will be operated and the "PA" lead will be opened. Ground will be removed from the "DA" lead also by the operated (DP) relay.

DISTRICT GROUP AVAILABLE OS 106-1

Assuming all sender links idle, ground is furnished on all "PA" leads 0 to 9. Assuming all sender groups idle, all SSL (GB) relays will be normal and the ground from the idle links is extended through all the normal SSL (GB) relays. The district group being idle as indicated by no "MB" plug and the SSL (DPO) relay normal, the ground is extended over the "TA" and "TB" leads to the line link controller circuit. Idle links on the line link frame are indicated by normal LL (T) relays as covered under "Test for Busy Links," all LL (G) relays operate. The "TA" leads operate the even numbered (G) relays and the "TB" leads operate the odd numbered (G) relays. The operated LL (G) relays indicate districts available with links to idle senders. OS 106-1 shows the circuit to one subscriber's sender link frame. It must be remembered each line link frame has circuits to four other subscriber's sender link frames as shown on LL relays (RS) and (RSA).

Ground on the "DA" lead from the SSLs' (DP) relays, operate the LL (PA) relay. The "DA" leads from the five subscriber sender link frames are common tied at the LL (RS) relays.

ROTATION OF DISTRICT GROUP PREFERENCE OS 108-1 105-1

In order to prevent an originating subscriber from always getting the same district junctor and same sender in periods of light traffic, the circuit is arranged to alternately prefer one of two groups of districts, each being preferred alternately on successive calls. To do this LL (RP) and (PR) relays are connected in a W & Z relay combination for the purpose of changing the position of the (RP) relay after each call. The LL (RL) relay operates on the release of the controller circuit after the subscriber has been connected to a sender. Assume LL (RP) and (PR) relays normal. When the LL (RL) relay operates, it operates relay (PR) which locks. Relay (RP) does not operate at this time due to the ground shunt on its 226 ohms of battery. When the (RL) relay releases, the shunting ground is removed and relay (RP) then operates to the ground on relay (PR). On the next call when the (RL) relay operates, it shunts down relay (PR) and holds (RP) relay operated. When the (RL) relay releases, relay (RP) releases. With the (RP) relay normal, the "A" leads are connected through and when the (RP) relay is operated, the "B" leads are connected through.

DISTRICT GROUP SELECTIONS OS 108-1, 108-2

Associated with each (G) relay is a F, X, D & K cross connection punching. Eight cross connections are required per LL frame from the (RP) relay to two (G) relays. The reason for these cross connections is: the preference may be changed from time to time if desired, to distribute the wear over different switches. OS 108-1 shows the D & KA punchings cross connected to the (GO) relay and the D & KB punchings cross connected to the (G2) relay. (X & F cross connections covered later.) (GO) and (G1) relays are associated with the first group of district junctors located on the LL secondary switches 0 and 1. (G2) and (G3) are associated with the second group of district junctors located on the LL secondary switches 2 and 3 and so on up to and including switch 9 and LL (G) relay 9. With the (RP) relay normal, group 0 district junctors on switch 0 will be preferred and with the (RP) relay operated group 1 district junctors on switch 2 preferred. With this arrangement the district preference is changed on every call. If any or all LL (G) relays are operated, resistance battery, from the LL (VS) relay operated is closed through to operate a LL (D) relay. If LL (RP) relay is normal and all LL (G) relays operated, LL (DO) relay will operate. If the LL (RP) relay is operated and all LL (G) relays operated, LL (D1) relay will operate.

If lower numbered LL (G) relays are normal, the operating path for a LL (D) relay is relayed through the contacts of the lower numbered normal LL (G) relays to the first operated LL (G) relay and its associated LL (D) relay operates.

There are five LL (D) relays, designated 0 to 4, on each line link frame and they are associated with the five groups of district junctors appearing on the LL secondary switches. Each LL (D) relay is connected in a chain circuit with other LL (D) relays located on other LL frames that are associated with the same group of district junctors. If the group of district junctors multiple to five LL frames, five LL (D) relays will be in the chain. If the district junctors multiple to six LL frames, six LL (D) relays will be in the chain. The (D) relay number indicates the group number it is associated with on the LL frame. OS 108-1 shows a example of the five (D) relay chains on one LL frame and how they tie to other LL frames (D) relays. Group 0 of LL frame 0 is multipled to four other LL frames. The group of twenty junctors, from DL frame - group 0, multiples to the five LL frames, listed above. Group 1 on LL frame 0 has five LL (D) relays in its chain and they connect to SSL frame - group -. RM1 . Group 2 on LL frame - has only four (D) relays in its chain and they connect to SSL frame - group -. LL frame - group 3 has five and group 4 has six (D) relays in the chain. RM 1 for all groups on LL frame 0, as an example.

The (D) relays are connected in this chain, to give operating preference as well as functional preference, in a definite order. The (D) relay of a chain that has functional preference is called Fig. 9A on SD-25553. Intermediate (D) relays are Fig. 9B and the last relay in the chain, Fig. 9C. If several LL frames attempt to seize this DJ group at once, more than one (D) relay in the chain may operate at a time. Other (D) relays in the chain may operate if the operating ground has not been broken by an operated (D) relay. However, if the (D) relay of Fig. 9C is operated, no other (D) relay in this chain can operate.

The purpose of the LL (D) relays in a chain circuit is to allow only one line link frame at a time, associated with this chain circuit, to gain access to the district junctor group. This is done by the functional preference feature SL lead on the LL (D) relays. Due to the SL lead, from the SSL being chained through the LL (D) relays, preference is given to the first LL (D) relay Fig. 9A.

In our case LL (GO) relay being operated, the resistance battery from the LL (VS) relay operated is extended to operate LL (DO) relay of the chain associated with SSL frame - and group 0.

On newer type installations (SD-25553 LL and SD-25554 SSL) district junctor group selection is made in a similar manner to older types. Contact numbering and figure designations for the (D-) relays are different on newer types.

In offices where older types are used in conjunction with newer types, (D-) relays of both will be chained together. Thus the functional preference lead, "SL", for example, will be through B 2/3 of normal (D-) relays in older types and three Through T 8/9 of normal (D-) relays in the newer types.

SEIZURE OF SSL CONTROLLER OS 108-1

The LL (D) relay in operating, locks and prevents the operation of other (D) relays lower in the chain. Our LL relay (DO) being Fig. 9A, others may operate but this (D) relay has functional preference. The operated LL (DO) relay extends the ground on the GP lead to operate SSL (GPO) relay.

There are five SSL (GP) relays designated 0 to 4 and they are associated with the five groups of district junctors on the District Junctor Frame. Only one group of junctors on the frame can be served at a time. The purpose of the SSL (GP) relays is to allow only one group to be served at a time. The SSL (GP) relays are connected in a chain circuit which gives operating and functional preference the same as do the LL (D) relays. (GP4) relay has operating preference and relay (GPO) has functional preference.

SSL (GPO) relay in operating, locks and operates the SSL multicontact group relay (GO). Other SSL (GP) relays may operate, but (GPO) has functional preference.

The SSL (GO) relay operated, operates LL (GE) relay and locks the lowest operated LL (G) relay, from the same ground on the SSL (D) hold magnets over the PA lead, that operated the LL (G) relays originally. The PA lead ground is relayed through the operated SSL (GO) relay and it becomes the SEL lead and connects to the LL SL lead.

When the LL (GE) relay operates it opens the operating path for all LL (G) relays and all (G) relays release except the lowest numbered locked one. (This is the case with LL (RP) relay normal. With LL (RP) relay operated LL (G1) relay is at the end of the chain.) LL (GE) relay also operated LL (DS) relay and by opening the DA lead it releases LL (PA) relay.

The (CK) relay SSL is used in newer types to open the operating paths of the (GPO-4) relays as soon as possible after a (GP-) relay has operated and locked.

REGULAR SENDER GROUP TEST OS 109-1

When an SSL (G-) relay operates it closes ten "GT" leads through to off normal contacts of (C) hold magnets on the secondary switches which may be used as sender links between the primary switches on which the selected group of district junctors are located and the five secondary switches which serve the ten subgroups of senders from the normal contacts of the (C) hold magnets to normal contacts of relays (R1) and (R2) over "GT" leads to relays on the miscellaneous relay frame. If the subgroup is not in use the (SGE) relay will be normal and if all senders are not busy or the subgroup made busy relay (SGB) will be normal. If relay (SGB) is operated it will operate the (GB-) relay in the sender link and control circuit opening the operating path for the (SG-) relay. When a sender is idle its (SB-) relay is normal. With any two of the (SB-) relays in a subgroup normal the "GT" lead will be grounded, operating the (SG-) relay in the sender link and control circuit, indicating (1) that there are at least two senders in the subgroup idle, (2) the group is not made busy and (3) not being used by another sender link and control circuit, (4) that there is an idle sender link between the primary switch being used and the secondary switch serving the subgroup of senders. (Operation of (SGE) relay covered, OS 111-1.

The reason for selecting a sender group with at least two senders idle is to load all sender groups before the last sender in any group is used. If all ten senders in several groups on an SSL were fully loaded before the last choice sender group was used, there may be cases where a district junctor group could not obtain access to a sender because of no links available to this idle sender group and yet it could have idle links to the sender groups fully loaded.

In our case let us assume all links and sender groups available and at least two senders idle in each group, so all (SG) relays operate.

RESERVE SENDER GROUP TEST OS 109-1, 110-1

If sender subgroup selection has not been made before relay (DS) operates, this selection will be made on a "reserve" basis since the operation of relay (DS) indicates that an interval has elapsed which would normally be sufficient to complete sender subgroup selection. The operation of relay (DS) causes relays (R1) and (R2) to operate which in turn disconnect the sender subgroup test relays (SG0) to (SG9) from the "GT" leads and connect them to the ten "RT" leads. The (SG0) to (SG9) relays can operate to ground on the "RT" leads provided the corresponding links are idle. The fact that the (GB-) and (SGE) relays are normal, is an indication that the sender subgroup is not made busy by the "make busy" jack on the sender make busy frame or not held busy by another control circuit and that there is at least one idle sender in the subgroup. The operation of the SSL (DS) relay is covered under OS 110-1.

LINE LINK FRAME SELECT MAGNET OPERATION OS 108-2

When the SSL was associated with our LL, LL (DS) relay operated. LL (LS) relay operated during line selection and identification. Ground is now closed to operate LL (DF-) relay associated with the operated LL (D-) relay.

There are five (DF) relays per line link frame and they are associated with a (D) relay of the same number. The (DF) relays are used for closing through several leads to the SSL controller circuit, including the class of service leads.

The LL (G) relay governs the (DA) or (DB) relay operation.

If the LL (G) relay operated is an even numbered relay the (DA) relay will operate; likewise if the (G) relay is an odd numbered relay, the (DB) relay will operate.

There are five (DA) relays and five (DB) relays on a line link frame and they determine which ten of the 20 district junctors, in a group, are to be used. They do this by closing through the ten secondary hold leads to the ten secondary hold magnets of a particular secondary switch. Each (DA) or (DB) relay operates a particular primary select magnet associated with it on any primary switch and also any secondary select magnet on a particular secondary switch. The (HG) relay operated determines in which primary switch this particular primary select magnet operates and which secondary select magnet operates in the particular secondary switch. Example is LL (DA-) operates primary select magnet No. 0 of primary switch 5 and also secondary select magnet 5 of secondary switch 0. The number of primary select magnets, in a horizontal group, to operate is controlled by the number of bays equipped on the line link frame.

The LL (DA-, DB-) relays also operates the SSL (BA-, BB-) relays. If the LL (DB-) relay operated, it would operate the SSL (BB-) relay.

The SSL (GO) relay previously operated, operates SSL (ON) relay.

On newer type LL (SD-25553) and SSL (SD-25554) LL select magnets are operated in a similar manner to older types LL (SD-25003) and SSL (SD-25004).

INDICATING A BUSY SSL FRAME TO THE LINE LINK FRAMES OS 106-1

The SSL (ON) relay in operating operates the SSL (ON1) relay. It also grounds the off normal ground lead of the SSL controller circuit.

The SSL (ON1) relay locks to the "ON" ground lead and also ~~operates~~ LOCKS SSL (TS) relay which starts the SSL timing circuit OS 124-1. The (ON1) relay also operates the SSL (DP0 to 4) relays.

There are five (DP) relays and they are associated with the five groups of junctors on the district junctor frame. The SSL (DP) relays in operating opens the "DA" leads to all line link frames associated with this SSL frame. OS 106-1 shows SSL frame and five line link frames associated with it, one for each group. It must be remembered that from 3 to 6 other line link frames are also associated with each group. The SSL (DP) relay operated opens up its "PA" lead to all line links associated with it. The opening of the "PA" leads removes grounds from the "TA, TB, RA, & RB" leads causing all associated line link controller circuit (G) relays to release (OS 108-1); except that the LL frame that has seized this SSL will have its associated (G) relay locked up to the SSL over the "SL, SEL and PA" leads which now is routed through the operated SSL (G) relay. The release of the LL (G) relay changes the preference and the LL circuit again functions to operate another (D) relay.

With the SSL (DP) relays operated, no LL will attempt to gain access to this SSL as the LL controllers (G) relays associated with this SSL will not operate due to the "FA" lead being opened.

INDICATING WHICH DISTRICT JUNCTORS IN SELECTED GROUP OF TEN ARE IDLE OS 110-1

When the SSL (GPO) relay operated previously, it operated SSL relay (CK). (CK) relay operated relay (RS).

The SSL (RS) relay operates the SSL (DE) relay. The (DE) relay closes through the SSL (D) relays operating paths to the SSL (BA) and (BB) relay multiple.

There are five (BA) and five (BB) relays in each SSL controller circuit. A set of (BA) and (BB) relays are used for each group of 20 junctors. The (BA) relay is used for the ten junctors in the A group and the (BB) relay is used for the ten junctors in the B group. The purpose of the SSL (BA) and (BB) relay is to connect the busy test (BT) leads from the associated district junctor circuits to the SSL (D) relays with the aid of the (DE) relay.

An idle district junctor circuit is indicated by battery on its BT lead.

When the SSL (BAO) relay operates 10 BT leads from the district junctor circuits selected are connected to the ten SSL (D) relays. The (D) relays that have battery on their associated BT leads operate, to ground furnished by the (ON) relay previously operated. For example: assume SSL (D) relays 2 to 9 operate, district junctors 0 and 1 being busy no battery is on their BT leads. The (BAO) relay operates an SSL (DA-0) relay also.

The (D) relays operated lock to battery furnished by their own contacts and ground on the (ON) relay. Any (D) relay operated, operates the SSL (DS) relay. The ground for operating the (DS) relay comes from either a (BA) or (BB) relay normal. This is to check that only one of the (BA) or (BB) relay is operated. If any two or more (D) relays are operated SSL (TM) relay operates and locks. If only one (DO) to (D9) relay operates during the combined releasing times of relays (RS) and (DE), the circuit assumes that the last idle district junctor circuit is being used to serve the call in which case a circuit is closed later (when relay (SL) operates) and relay (TM) normal to operate the district junctor group busy traffic register. If relay (TM) operates, it indicates that there are at least two idle districts available for serving the call and opens the path to the district group busy register. Relay (TM) operated also releases relay (DE) immediately without waiting for the slow release (RS) relay to release.

The release of relay (DE) prevents any more (D) relays operating should their associated district junctor become idle.

The operated (DS) relay starts the release of slow release relay (RS) and operates the (CA), (CB), (R1) and (R2) relays in the SSL. OS 122-1.

If OS subgroup selection has not been made before the SSL (DS) relay operates, this selection will be made on a reserve basis through the operated (R1) and (R2) relays, since the operation of the (DS) relay indicates that an interval has elapsed which would normally be sufficient to complete OS subgroup selection.

SENDER GROUP SELECTION OS 111-1, 112-1

Punchings G0 to G4 associated with the (GP) relays are cross connected to five of the SG0 to 9 punchings. These punchings are furnished so the cross connections can be changed from time to time to distribute the wear over the link switches.

In our example the following cross connections will be considered:

G0 to SG0
G1 to SG2
G2 to SG4
G3 to SG6
G4 to SG8

OS 111-1 shows five (GP) relays with G cross connection punchings and ~~four~~ FIVE (SG) relays 0, 2, 4, 6, and 8 with SG punchings cross connected.

When the (SG) relays operate, battery from the operated (GP) relay is closed through the G and SG punchings to operate an associated (LL) relay. A chain circuit through the operated or normal (GP) and also (SG) relays, govern which (LL) relay operates. In our example (GP0) and (SG-0) relay being operated. (LL0) relay operates.

There are ten (LL) relays designated 0 to 9 and they correspond numerically to Secondary Switches sender groups 0 to 9 the same as the (SG-) and (C-) relays. Each (LL) relay is associated with a particular sender group and is connected in a chain circuit with other (LL) relays of other SSL frames having access to this same sender group. OS 111-1 shows SSL frame (LL) relay 0 associated with the same sender group as other LL- relays on different SSL frames. The (LL) relay chain gives operating preference as well as functional preference in a definite order. The (LL) relay with operating preference is referred to as Fig. 7A on SD-25554-01 and the (LL) relay with functional preference as Fig. 7C. Intermediate (LL) relays are Fig. 7B. The purpose of the (LL) relays is to allow only one SSL at a time to have access to the sender group. The (LL0) relay in operating locks and locks the (SG0) relay. The (LL0) relay also operates relay (SS).

The operated (SS) relay opens the operating path of all the (SG) relays and they all release except the one locked to the operated (LL) relay. In our example relay (SG0) remains locked. The (SS) relay closes ground to the SEL and PA leads so that the line link controller circuit will not be dismissed if the last available path is used to serve the call. OS 106-1.

The release of the (SG) relays 1 to 9 closes a chain circuit to operate the (OC) relay.

In our example the operated (OC) relay extends a ground from the operated (SG0) relay to operate multicontact sender cut in relay (CO) and also to operate the two primary select magnets 0 one on each primary switch 0A and 1B. Note: Reverse SG0 to SG9 numbering due to error.

We have now established the location of the sender group selected as being on secondary switch 0 and we know the link associated with secondary switch 0 and district group 0 must be used. (District group 0 previously selected) therefore the select magnets 0 of primary switches 0 and 1 were operated.

Newer type installations using (SD-25554) are basically the same as (SD-25004). The figures are designated differently and contact numbering is in most cases different.

With one or more (SG-) relays operated, a circuit is closed to the associated (LL-) relay of Figs. D, E, or F corresponding to the available subgroup preferred. The (LL-) relay operated (1) prevents other SSL's from subsequent seizure of the subgroup, (2) locks its associated (SG-) relay, (3) operates (SS) relay, and (4) starts the release of (CH1) and (CH2) relays. The (CH2) relay will not have time to release if (C-) relay operates as will be described.

Operation of relay (SS) releases all (SG-) relays not locked. Relay (OC) operates when any one (SG-) relay is operated and the other nine are released. Relay (OC) operated, operates (C-) and the two associated primary select magnets.

There is one SGE relay for each subgroup of senders, operated by the C- relay. The SGE relay in operating makes its group of senders test busy to other sender link frames by opening the GT & RT leads.

Newer SSL's are arranged to provide an alarm if a contact chain or relay failure occurs in the preference chain of a sender subgroup, and to automatically make that subgroup busy.

When the subgroup is idle (CH1) and (CH2) relays are operated if the contact chains are continuous. If the operational chain is open relay (CH1) releases, releasing (CH2) relay. If the functional chain is open, relay (CH2) releases directly. (CH2) releasing, operates (CH3) which closes a path from (SGB) relay to the CTI. When the SSL fails to handle a call, times out and records a failure on the CTI, the CTI operates SSL (SGB) relay. If the CTI is busy relay (SGB) operates when relay (CH3) has operated.

The "LL" lead to the miscellaneous circuit for the Sender Make Busy Frame is grounded for an audible and visual alarm by the operated (SGB) relay provided there are two or more senders idle in the subgroup.

SENDER SELECTION OS 113-1

There are ten multicontact, cut in (C) relays designated 0 to 9 on each SSL frame. Each (C) relay is associated with a sender subgroup appearing on a secondary switch on the SSL. The (C) relay number and the secondary switch group number are the same. The (C) relay is used for connecting the miscellaneous leads from the LL and SSL controller circuits to the sender and the sender selector circuit. Some of these leads are the class of service leads which were grounded in the LL by the LL (LT) and (DF) relays. These leads are now extended into the sender subgroup but they will not be covered until their paths are complete. Other leads connected through in part are the RL, ON, GS, and SL. Two frame leads are grounded by the operated (C) relay. Their circuit is not complete and they will be covered later. OS 118-1.

The operated (CO) relay operates the sender selector circuit (SO) relay by grounding the PF lead.

There is an (S) and (SB) relay for each sender in the office and they are designated 0 to 9 in each sender subgroup. The (S) and (SB) relays are part of the sender selector circuit and they are located on a miscellaneous relay bay. When the sender is idle its associated (SB) relay is normal and when the sender is busy in service or made busy the (SB) relay is operated. If the sender preferred is busy, a chain circuit is closed through the operated (SB) relay or relays, if more than one sender is busy, to the first normal (SB) relay, in the chain, to operate its associated (S) relay. This chain circuit is a little different from other chain circuits covered inasmuch as it hunts backward from (SB0) to (SB9) and then down through (SB8) 7, 6, 5, 4, 3, 2, to (SB1).

When the C relay operated it closed ground from the operated G relay to one of the leads P0, P2, P4, P6 or P8 of Fig. A, depending upon where the preference is to start in the sender subgroup chain circuit on the SB relays. This arrangement distributes wear over the various senders and the link secondary crosspoints in accordance with the district group being served.

G-0 connects ground to P0 lead.
G-1 connects ground to P2 lead.
G-2 connects ground to P4 lead.
G-3 connects ground to P6 lead.
G-4 connects ground to P8 lead.

A sender selector circuit S-relay operates and locks. There is an S relay for each sender in the office. These relays are divided into subgroups of ten, designated 0 to 9, and wired in a double transfer chain circuit. They are located on a miscellaneous bay adjacent to a number of originating sender frames.

The P leads are wired to every other SB relay in the sender subgroup starting at the SB-0 relay so that the testing of senders can start at any one of five different points, depending upon what P lead is grounded. The preference chain functions from 9 to 0. Zero when busy reverts to nine.

Any operated S relay in the chain except the last one in the sender selector circuit will lock from battery through its operated contacts to ground on the CG lead provided by the operated C relay. Battery for the last S relay is independent of its operated contacts.

One secondary select magnet operates, from operated (S) relay.
Sender selector circuit P relay operates, from S relay.
Ground is connected to the SC lead of the selected sender.

The connection of ground to the SC lead of the sender starts the subscriber sender to register the class of service and district link and connector frame indication.

The secondary select magnet that operates is on the switch whose C relay is operated and its designation agrees in number to the operated S relay of the sender selector circuit.

An additional ground is connected to the operated secondary select magnet.

OPERATING THE SSL PRIMARY AND SECONDARY HOLDING MAGNETS OS 114-1

The SSL primary and secondary switch select magnets having operated, the SSL controller circuit is now ready to operate the holding magnets. The SSL (OH) relay's operating path is wired in a manner to check the following conditions before the holding magnets are operated; the SSL (DE) relay normal and the (DS) relay operated indicates there is a district junctor circuit available. The (SL) relay normal indicates no false ground on the sleeve lead to the sender. The secondary select magnet indicates it has operated by extending the (OH) relay's operating path. The sender cut in relay (C-) is checked operated. The sender selector circuit (P) relay operated indicates that the Subscribers' Sender has been selected and it prevents another secondary select magnet from operating by opening the (S) relay's operating path, thereby preventing double cross points in the secondary switch. The group relay (GO) is checked operated as well as two primary select magnets. The operating path for the primary holding magnets are cut through because ground from the operated (DA-) or (DB-) indicates one of these relays is operated. If all these conditions are satisfactory, SSL relay (OH) operates.

The SSL (OH) relay closes through, in part, the future operating paths for the SSL primary holding magnets and it also operates SSL relay (GH).

The (GH) relay locks and grounds the DP punching. The DP punching is cross connected to one of the five D punchings 0 to 4. The D punchings are wired to the even numbered (D) relays in a definite order. D0 punching is wired to the (D0) relay. D1 punching to the (D2) relay and so on up to D4 punching to the (D8) relay. With the DP punching cross connected to D0 punching, as is our example, district junctor 0 will be preferred. The reason for this flexible cross connection is so the preference may be changed from time to time, if desired, to distribute the wear over different district junctors.

Ground is extended from the operated (GH) and (OH) relays to the normal or operated (D) relays to operate the holding magnets on two primary switches. In our example we assumed SSL relays (D0) and (D1) normal and (D2) operated so the ground is extended to operate holding magnets (A2) and (B2) on primary switches 0 and 1.

When the (A) holding magnet operates, its operating ground is extended through the now closed primary switches' cross points to operate the holding magnets (C) and (D) on the secondary switch associated with the horizontal chosen on the primary switch. In our example (A2) holding magnet in operating, closes the cross points on the horizontal 0 and thereby operates the secondary switch holding magnets (C0) and (D1) of sender group 0.

CHECKING THE OPERATION OF THE SSL HOLDING MAGNETS OS 114-1

The (C-) holding magnet in operating, extends the same ground through the now closed secondary switch cross points into the sender on an S lead which comes back to the SSL controller circuit on an SL lead to operate the sleeves check relay (SL).

The operating of the SSL (SL) relay is an indication that the SSL holding magnets have operated closing their crosspoints and the sleeve continuity through the primary and secondary switches is satisfactory.

The SSL (SL) relay operated, releases relay (OH).

DOUBLE CONNECTION TEST OS 114-1

The (OH) relay, released, removes the operating ground from the SSL holding magnets (A), (B), (C), and (D), however, they do not release but remain locked or held through the SSL (DC) relay winding to ground at at the operated (SL) relay. If a false ground is on the sleeve lead, generally caused by double crosspoints, relay (DC) will be shunted and will not operate. In this case the SSL will time out and call in the Connector Trouble Indicator. If no false ground is found on the SL lead, SSL relay (DC) operates in series with the holding magnets. The SSL (DC) relay operates the SSL (DR) relay.

The controller circuit DC relay is used to detect double connections, that is, any trouble condition which may have caused the call that is being established to be crossed with an already established connection at any of the switches of the sender link frame. The SL relay in operating releases the OH relay which removes the short circuit from the DC relay and at the same time opens the GH ground that was previously supplied over one of the leads A-0 to A-9 inclusive for operating the proper set of A, B, C, and D hold magnets. With this A lead ground removed, the A, B, C, and D hold magnets are held operated through the DC relay winding to ground at the SL relay, and at the same time the holding current is sufficient to operate the DC relay, provided that there is no foreign ground on the sleeve. Should a foreign ground be encountered on the sleeve after the OH relay releases, the DC relay will fail to operate, since it will still be short circuited. In this case the circuit is blocked, causing the time alarm circuit to function as described later.

OPERATING LL SECONDARY SWITCHING HOLDING MAGNETS OS ~~114-1~~ 115-1

When the SSL relay (GH) operated and grounded the DP punching, this ground was also extended to an SH lead through the SSL (D) relays. In our example SSL (DO) and (D1) relays were normal and (D2) relay operated causes SH2 lead to become grounded. This ground is now extended to the line link controller circuit to operate the LL secondary holding magnet (D2). DH- magnet locks to a hold magnet through selected district junctor circuit.

OPERATING THE SUBSCRIBER'S LINE HOLD MAGNET OS 116-1

The operation of the district hold magnet on the line link frame, closes the crosspoints on the secondary switch. The closing of the crosspoints, extends the district hold magnets operating ground to ground the sleeve of the link associated with this crosspoint. In our example LL (DH2) on secondary switch (0) in operating, closes the crosspoints on horizontal (5) and grounds the sleeve of link (0) to primary switch (5). The ten LL (T) relays were connected to the sleeves of the ten links previously by the operation of the LL (HG) and (AC) relays. The placing of the ground on a link sleeve will operate the associated LL (T-) relay. In our example the LL (DH-2) operates, grounds the sleeve of link 0, and LL (TO) relay operates.

Ground from the SSL (RL) relay normal is extended to the line link frame through the operated LL (T) and (G) relays to the LL (LT) relay or relays to operate a line hold magnet. The particular line hold magnet that operates is determined by the operated LL (LT) relay which was set up during line selection. In our example only LL (LT-9) relay is operated so the ground from the operated LL (T-0) and (G-0) relays is extended through the normal LL (LT-0 to 8) relays and operated LL (LT-9) relay to ground the HM-9 lead and operate the line hold magnet (9) associated with the operated (HM) relay of column 03 and horizontal group 5 used as an example. The LL (HM) relay operated was determined during Vertical Selection. OS 104-1.

RECORDING CLASS OF SERVICE INDICATION IN THE SUBSCRIBERS SENDER OS 117-1

The line link frame's controller circuit indicates, to the subscribers' sender, the class of telephone service of the calling subscriber. The line link frames are wired for only one of the two general types of service, that is, coin or noncoin. More than one type of coin service can be placed on a coin line link frame and also more than one type of noncoin service can be placed on a noncoin line link frame.

Subscribers lines requiring the same class of service are placed in the same relative positions in each group of ten lines, so that the (LT) relay operated by the line is an indication of the class of service required by that line. Ten punchings designated "L0" to "L9", Fig. 13 are cross-connected to the six punchings designated "CR0-CR5" to operate class of service relays (CS0) to (CS5), so that a maximum of six classes of service may be passed into the sender link and controller circuit from any group of ten lines. The cross connection of the grounded relay contact leads "CA0-5", "CB0-5" and "CC0-5" to the ten "CS" or eight "S" leads depends upon the type of signal required by the sender. "CS" leads shown.

Where Senders Require Ground on One Lead

Where senders require ground on only one lead, giving a maximum of six classes of service per originating unit served by the same senders punchings "CA0-5" are cross-connected to the punchings "CS0-5" (option V) as required.

Where Senders Require Ground on Two Leads

Where senders require ground on two leads, giving a maximum of twenty-four classes of service per originating unit served by the same senders punchings "CA0-5" are cross-connected to punchings "CS0-5" (option V) and punchings "CB0-5" are cross-connected to punchings "CS6-9" (option H) as required.

Where Senders Require Ground on Three Leads

Where senders require ground on three leads, giving a maximum of thirty classes of service per originating unit served by the same senders, punchings "CA0-5" are cross-connected to punchings "SA-SE" (option T), punchings "CB0-5" are cross-connected to other punchings "SA-SE" (option T) grounding two out of five leads for a possible maximum of ten indications, and punchings "CCO-5" are cross-connected to punchings "SO-S2" (option T) as required. This feature is not shown on OS drawings.

RECORDING DISTRICT FRAME INDICATION IN THE SUBSCRIBER'S SENDER OS 118-1

The number of the district frame, on which this particular call is being placed, must be registered in the Subscriber's Sender. The sender later relays this information to the originating marker (OM). The purpose for transmitting this information to the OM is so the OM can be steered to the proper district frame to set up the connection between the district junctor on the district frame and the trunk on the office link frame.

When the sender (SC1) and (SC2) relays operated, they closed through the district frame indicating leads into the sender. Two district frame leads are grounded for each call. One of the leads grounded is an F0 to F9 lead and the other an F00 or F10 lead. If the district frame number is from 0 to 9, a like numbered F lead is grounded and also the F00 lead is grounded. If the district frame number is from 10 to 19, the F lead grounded is the same as the units number of the frame. The F10 lead is then grounded in this case. OS 117-1 shows an example of the district frame leads from different numbered (C) relays on ten SSL frames connecting to the sender (SC) relays.

In an example the (C0) relay of the SSL frame 0 grounds the F00 and F0 leads. The F00 lead ground operates the sender (F00) relay. The sender (F00) and (CS) relays operated lock to each other operating path by placing temporary ground on the off normal ground lead ON.

The F lead number is registered on the sender crossbar switch. The F lead grounded operates a like numbered select magnet representing a horizontal on the sender crossbar switch. Our F-0 lead ground operates select magnet (0). The select magnet in operating, operates the select bar and also closes its off normal contacts. The closing of the ON contacts extends the F-0 lead ground to operate the sender (SM-1) relay which in turn operates ON4.

The SM relays are used to operate the hold magnets of the sender crossbar switch. The sender (SM-1) relay locks the select magnet (0) to the ON ground lead. The (SM-1) relay operates the (SM-2) relay.

The (SM-2) relay operates the (SM-3) relay. The proper combination of CS relays and one of the F00 or F10 relays operated is checked by the (SM-3) operating path. An additional locking path is also furnished to the select magnet by the (SM-2) relay operated.

The (SM-3) relay operates the sender frame holding magnet (SM-2 in series). Relay (SM-1) is now released. The (SM-3) relay also operates the (RA-2) relay.

The (RA) relays are known as register advance relays and are used for advancing the holding magnets operating circuit. As the subscriber dials the digits the (RA) relays function to close the operating paths for the holding magnets in order, one at a time.

The (F) holding magnet in operating locks, closes the crosspoints on horizontal (0) and releases the (SC-2) and (SC-3) relays. Relay (SM-2) releases due to the ON ground shunt placed on its winding.

The F leads are opened by the (SC-2) relay releasing.

The (SM-2) relay in releasing, releases the (SM-3) relay and also releases the (0) select magnet.

The (SM-3) relay released removes the shunt from relay (RA-3) and it operates, operating the (RA-4) relay.

When the sender crossbar switch select magnet releases and the (SM) relays release, together with the (RA) relays properly set up, the crossbar switch is ready to record the A digit. However, dialing cannot begin as dial tone has not been received by the subscriber.

CHECKING REGISTRATION OF CLASS OF SERVICE AND DISTRICT FRAME RELAYS OS 119-1

When frame indication is being made on the sender crossbar switch, the sender (CK) relay is checking for class of service and frame relays properly set up. If, due to a cross between two leads, failure of a (CS-) or (F-) relay to release from a previous call or some other trouble, two (CS) relays 0 to 5 or (CS) relays 6 and 7, 8, and 9 or (F00) and (F10) relays are operated or two select magnets operated, resulting in the closing of two crosspoints on the (F) register, one of the leads "CK-3" and "CK-4" will be grounded and a circuit is closed to operate the sender (CK) relay. The operation of the (CK) relay will prevent the sender from advancing. The SSL frame's controller circuit will then time out, call in the controller trouble indicator and release.

If the combinations of (CS) and frame relays check satisfactory sender (CK) relay does not operate indicating a satisfactory check.

RECEIVING DIAL TONE OS 121-1

When the LL Line Hold Magnet operated, OS 116-1, it opened the tip and ring leads from the subscriber's instrument circuit to the line relay and closed them to the district junctor. The line relay then releases and opens the "LT" lead ground which was holding LL (RE) relay operated and it releases.

Ground from the normal LL (RE) relay is closed through the SSL on an ON lead to the sender to operate the sender (ON-1) relay. The sender (ON-1) relay operated indicates the following:

1. The line hold magnet has operated.

2. No double (CS) or (F) relays operated in the sender (CK normal).

3. Frame number has been recorded on the sender crossbar switch (RA-4) operated.

The sender (ON-1) relay in operating connects ground to the temporary grounded ON ground lead and closes the T & R leads to the sender (ON-3) relay.

Tip Party Test Before Dial Tone

When the sender class of service relays were operated, a circuit was closed for either making or canceling tip party test. Tip party test is cancelled on all coin class and single party lines. If the (CS-7) and any one of the (CS 3-4 or 5) relays are operated, tip party test is made. When tip party test is made, the T & R leads are connected together by the normal (ON-3) relay and extended to the (TP) relay winding. On ring party lines the (TP) relay in the sender does not operate. On tip party lines the (TP) relay operates from the ground at the subscriber's line circuit. In either case relay (ON-3) is operated by the (TP) relays not shown on OS 116-1. (TP tests covered later on OS 213-1.)

Canceling Tip Party Test

If any of the (CS-0, 1, or 2) relays are operated, or if the (CS6 or CS8) and any of the (CS-3, 4, or 5) relays are operated, tip party test is canceled by the operation of relay (ON-3).

Completing the Tip and Ring Path to the Sender (L) Relay

Relay (ON-3) operated extends the ring to battery on the sender (L) relay winding and the tip to ground on the (TN) repeat coil. The sender (L) relay operates from the T & R short supplied by the subscriber's instrument. The tip and ring path is from the subscriber's instrument, to the MDF, the line link frame primary and secondary switches, the district junctor grouping frame, the SSL primary and secondary switches and into the sender. The sender (L) relay operates the sender (L-1) and (SR) relays in series. Relay (SR) grounds the tertiary winding of the repeat coil which is connected to the tone supply. This causes the tone to be induced to the P and S windings of the repeat coil associated with the tip and ring. The dial tone is heard by the subscriber and is an indication dialing can be started. The sender (L) relay will be described under dialing.

HOLDING THE LL AND SSL CROSS POINTS OS 121-1

After the tip and ring leads have been closed from the subscriber's instrument to the sender, the sender takes over control of the crosspoints in the LL and SSL.

The sender (ON-1) relay previously operated, operates the select circuit (SB) relay. The operated (SB) relay will indicate that this sender is busy to future calls attempting to seize a sender in this sender subgroup.

The sender (SR) relay operates relay (SR-1). Relay (SR-1) operates the sender (ON-2) relay from ground at the SSL (DR) relay operated.

The sender (ON-2) relay locks itself and the (ON-1) relay to the (ON-1) relay ground. It places ground on the S lead to lock or hold the SSL holding magnets (A, B, C, and D). It also grounds the RL lead to operate the SSL (AB) relay. (Note: AV4 should be shown normal.)

Ground from the operated off normal contacts of the SSL (A) hold magnet, through the district junctor 10 ohms of resistance locks the LL secondary and primary hold magnets. The reason for having a resistance ground in the sleeve circuit is: A solid ground would short out the special high frequency current applied to the sleeve circuit on number check calls, whereas the resistance ground does not.

RELEASING THE LL AND SSL CONTROLLERS OS 121-1

The SSL (AB) relay in operating operates the SSL (RL) relay. The SSL (RL) relay in operating starts the release of the SSL relays in cascade, one of which is the (GH). When SSL (GH) relay releases, the LL (RL) relay is operated over the RL lead to the SSL and back on an H lead to the same 10 ohm ground that is holding the LL hold magnets. If the holding sleeve is not continuous ground will not be returned over lead H and LL relay (RL) will not operate. The timing circuit will then function to bring in an alarm under this condition.

The operation of the LL (RL) relay causes the relays of the LL controller to release in cascade.

The crosspoints are now held by the sender and the LL and SSL controller circuits are ready to accept another call.

DISTRICT JUNCTOR GROUP REGULAR AND RESERVE TEST OS 122-1

When the (ON1) relay operated, the five (DP) relays operate as shown on OS 106-1.

When any or all of the relays (AB), (DS) or (AL) operate a circuit is closed to operate the (CA-) relay. The (CA-) relay locks to its own T 3/4 contacts, and also to the B 11/12 contacts of its associated (DP) relay. The (DP-) relay locks through its secondary winding, normal (RA-) and (RB-) relays to T 3/4 of operated (CA-) relay. Relays (RA-) and (A-) are shunted at this time by ground at T 3/4 (CA-) relay and contacts 20 and 23 of the (G-) relay. (The circuit action is the same for the B subgroup of District Junctors.)

When the (G-) and (ON1) relays release, the ten "BT" leads associated with the subgroup of ten District Junctors serving the call are cut through to the operated (CA-) relay to the windings of the (RA-) and (A-) relays. These leads will be used to determine whether there is one or more District Junctor still available in the subgroup of ten District Junctors used to serve the call.

If there are two or more District Junctors available the (RA-) and (A-) relays will operate. Note: The (A-) relay being marginal will operate only when its winding is in parallel with two or more 1350 ohm "BT" leads.

The operation of the (RA-) relay releases its associated (DP) relay by opening up the (DP) relay secondary winding. The operation of the (A-) relay shunts the battery at the (CA) resistance and releases the (CA-) relay. The (D-) hold magnet ground will be connected to normal T 7/8 of the (DP-) relay, T 1/2 (CA-) relay to the "TA" lead to LL and Controller Circuit. (The circuit action is the same for the B subgroup of District Junctors - Fig. C.)

DISTRICT JUNCTOR GROUP RESERVE TEST

If only one District Junctor is idle in each subgroup of ten District Junctors that serve one Line Link frame, the (A-) relay in the SSL controller circuit being marginal will not operate, but the (RA-) relay does operate. The (CA-) relay therefore cannot be shunted. On OS 108-1 the (G-) relay in the LL circuit operates over "TA" or "TB" leads, through normal (RS) and (RSA) relays. The LL (PA) relay is still held operated by the normal (DP-) relay in the SSL controller circuit. The slow release (SR) relay in the LL controller circuit will release when the LL (LS) relay operates. Relays (RS) and (RSA) now operate in the LL controller circuit, transferring the "TA" and "TB" leads to the "RA" and "RB" leads, to allow the (G-) relay in LL controller circuit to operate on a reserve test basis.

On OS 122-1, both the A and the B subgroup of District Junctors are shown. If no District Junctors are available in either subgroup, then the (RA-) relay in the A and (RB-) relay in the B subgroup cannot operate.

The (DP-) relay will remain operated until either the (RA-) or (RB-) operate. With (DP-) relay operated, ground is removed from the "DA" lead to the LL; and also all the possible paths to ground, for leads "TA, TB, RA, and RB," are open thus indicating to the LL controller that these District Junctor subgroups are not available to serve a call.

The reason for this circuit function is to load all subgroups of District Junctors with calls before the last District Junctor is used.

ALARM AND TRANSFER TIMING CIRCUIT - LINE LINK CONTROLLER OS 123-1

Each two line link frames are arranged to work as mates, so if trouble develops in the control circuit of either frame, it will continue to serve its subscribers, using the control circuit of its mate frame. Under this condition the two mate frames use the control circuit of one of them as a common control circuit, calls being served alternately on the two frames. Before a frame in trouble can have calls served by its mate frame, it must time out. The timing circuit then functions to prevent the operation of certain relays in its controller circuit and the mate frame takes over.

When a subscriber starts a call, relay (CA) operates grounding the armature of interrupter (IA). On terminating calls relay (LA) grounds the (IA) interrupter. When the (IA) interrupter makes its "B" contact, relay (TA) operates and locks. If the call is cleared before the "F" contact of (IA) interrupter makes the circuit functions in the regular manner and the (TA) relay restores. If the "F" contact makes before the start ground is opened, relay (TA1) operates. Relay (TA1) operated locks and opens the ground supply for relays (CA) and (FA) causing the frame to disconnect from the control circuit. Relay (TA1) operated supplements the start ground on the (IA) interrupter, locks relay (TA) and provides an operating circuit for relay (TA2) from contact "B" of the interrupter. When the (IA) interrupter makes its B contact, relay (TA-2) operates and locks.

The (TA-2) relay operated, removes one locking path of (TA-1) relay, lights AL lamp, operates the minor alarm and aisle pilot, removes the battery supply for relays (CA), (FA), (LA). The battery supply is also removed from relays (AC) and (HC) OS 102-1.

When the (IA) interrupter breaks its B contact relays (TA-1) and (TA) release.

The home controller circuit is now out of service and subsequent calls are served by the mate controller circuit through the operation of relay (CB) on the home frame.

If the trouble that caused the time alarm condition was in the control circuit, no further time out will occur after the initial time out had taken place. If, however, the trouble was in the frame equipment and a call is blocked after starting through the mate controller circuit, relays (TB), (TB1) and (TB2) will function to remove the mate frame controller circuit from service. The operation of relay (TB1) opens the locking circuit for relay (TA2) which releases and restores the home controller circuit to service by furnishing battery to the various relays. Each time a call is blocked a transfer is made from one side of start circuit to the other, approximately six seconds is allowed to serve each call before an alarm functions.

When alarms have been coming in on a frame and the trouble has not been located due to the transfer, a 298-A plug may be inserted in the (hold jack) to prevent operating the (TA1) or (TB1) relays as the case may be, but provides a path to operate the (M) relay at a time when the (TA1) or (TB1) relay would normally operate. Relay (M) operated sounds the major alarm and lights the red (MA) light of the associated frame. Relay (TA-1) or (TB-1) normal prevents the operation of the (TA-2) or (TB-2) relay. By preventing the (TA-2) or (TB-2) relay from operating and cutting off the battery supply the operated controller circuit relays remain operated. With this condition the switchman can observe how far the call has advanced and determine where the circuit failure occurred.

Maintenance Forces are cautioned to take these readings quickly and remove plug from the (H) jack as both originating and terminating calls are blocked under this condition.

When the mate frame control circuit is plugged busy, indicated by its (MB) relay operated, the (M) relay will operate when the (TA1) relay operates, sounding the major alarm. Should the (TA1) relay be falsely operated and a time out occurs to operate relay (TB1), the (M) relay will also operate under this condition.

CONTROL TROUBLE INDICATOR

CONTROL CIRCUIT TROUBLE INDICATOR - KEYS

ACO	The ACO key is the alarm cutoff key which when operated opens the locking path of the (CC) relay of the miscellaneous circuit Fig. 6. With the (CC) normal the circuit path to the minor alarm circuit is open.
LP	This key is provided to save unnecessary usage of the display lamps. When operated it closes the path to operate the (BC) relay which through its operated contacts supplies battery to the indicating lamps.
RL	The RL key furnishes the path to operate (IRL) relay. The normal (IRL) relay provides the ground for locking up the recording relays and lamp indications.

CONTROL CIRCUIT TROUBLE INDICATOR - LAMPS OS 131-1

LLT- LLU- (0-19) (100-119)	These lamps indicate the line link frame involved on the trouble display. The LLT- indicating the tens digit and the LLU- indicating the units digit. The combination of LLT- and LLU- being used to effect economy in lamps and lamp mounting space. Thus, for example, line link frame 28 will be indicated by the (LLT-2) and (LLU-8) lamps.
SLF (0-19) (100-119) (EM-0) (EM-100)	These lamps indicate the subscribers sender link frame which has an indication recorded.
SGP (0-39)	The SGP lamps indicate the sender group used. It should be noted that this indication is the actual group number and not the group within the frame.
S (0-9)	The S lamp indicates the particular sender within the group.
DG - 0-4	The DG- lamp indicates the district junctor group.
DSG-0-2-4-6-8 DSG-1-3-5-7-9	The DSG- indicates the particular group of 10 district junctors.
D - (0-9)	The D lamps operated indicate all the district junctors within the group of ten that are idle.
OC	The OC lamp indicates sender group selection has been completed and ground has been supplied to the winding of the OC relay in the control circuit.

DS	The DS lamp indicates the completion of district selection and that battery has been supplied to the winding of the DS relay of the control circuit.
OH	The OH lamp indicates completion of sender selection and the SSL Primary and Secondary hold magnets can be operated and that ground has been applied to the OH relay winding of the control circuit.
GH	The GH lamp indicates a circuit has been closed to operate the hold magnet meaning that ground has been supplied to the winding of the GH relay of the control circuit.
SL	The SL lamp indicates the crosspoints are closed in the SSL Ground on the sleeve lead from the SSL control circuit (GH) relay operated through the SSL crosspoints and the sender and back to the winding of the (SL) relay of the SSL control circuit operates the (SL) relay.
DC	The DC lamp indicates a double connection with a busy link.
AB	The AB indicates the release stage of the SSL has been reached. This indicates the sender has taken over control of the crosspoints.
TC	The TC lamp indicates the failure was on a test call from the district junctor test frame.
ON	The ON lamp lighted indicates a ground on the winding of the ON relay indicating the control circuit is off normal.
SG (0-9)	The SG lamp indicates which Sender Group on the frame has been selected.
H	The H lamp indicates there is ground on the lead to operate the line hold magnet. However, the check is only made for the presence of ground in the SSL control circuit.
RL	The RL lamp indicates ground has been supplied to the RL lead toward the line link. This is checking the holding sleeve ground (LL) and if it is not continuous the RL in the LL will not operate.
CRL (0-19) (100-119) (EM-0) (EM-100)	This lamp indicates that the associated SSL control circuit called for the trouble indicator while it was serving some other controller.

TROUBLE INDICATOR CIRCUIT FOR SUBSCRIBER SENDER LINK AND CONTROLLER AND TIMING CONDITIONS

The control circuit trouble indicator is used in crossbar offices to provide the information necessary for the analysis of trouble conditions that cause the SSL control circuit to time out.

Each SSL control circuit has been provided with five connector relays (CIA) to (CIE) which when operated, under control of the indicator circuit, extend leads from the SSL controller circuit into the trouble indicator. These leads provide the circuit paths to indicate the equipment used for a particular call and the progress of the call. This information is recorded in the indicator by means of relays and lamps. When the trouble indicator has recorded this information it causes the SSL control circuit to release.

A preference circuit is provided which allows only one SSL control circuit to take possession of the trouble indicator at one time.

A minor alarm is given while a trouble recording is on the CTI, but if another SSL control circuit attempts to seize the indicator while it is busy, a major alarm results.

One trouble indicator has a capacity for serving 40 subscriber sender link frames, 160 line link frames, 40 subgroups of senders and 42 sender link controllers including two emergency controllers. The summary of the Timing Stages are listed on the following pages. Refer to OS 124-1, 130-1 and 131-1 for circuit action. Complete text can be reviewed in Section 3.

SSL TIMING STARTS

When the SSL is selected by a LL frame and on the operation of the SSL (ON-1) relay, the SSL (TS) relay operates and timing starts. If the call is disposed of within 2 to 2-1/2 seconds the release of the SSL (ON-1) relay drops the SSL (TS) relay. The (TS) relay releasing removes the battery from the timing circuit relays and they release.

TRAFFIC RELEASE

Under normal traffic conditions, sender group selection should have been completed before relay (ZA) operates. ((SG) relay operated indicates sender group selection completed.) If sender group selection has not been made the (SG) relays will be normal and the (TR) relay operates. The (TR) relay functions to release the line link frame from this SSL. It may be some time before a sender group may be available to this line link frame group. The call might be completed in a shorter time on another SSL frame, so transferring the call to another SSL frame is practical. If the SSL (SG) relays are normal the (TR) relay operates.

No alarm is given on this type of release. The line link (GE) and (G-) relays release which permits another district group to be selected. This SSL will release when the SSL (GP) relay releases the SSL (G) relay.

FALSE START RELEASE SSL

If the calling subscriber disconnects after relay (GH) operates, the abandoned call cannot be recognized until the sender circuit has progressed to the point of testing the dialing tip and ring leads for line closure. If the tip and ring test open due to the subscriber hanging up or a trouble condition wherein the tip and ring conductors through the switches of the established connection are actually open, the (L) relay in the sender circuit will not operate so sender relay (SR1) will be normal also.

No alarm is given on this type of release. The line link releases and in turn releases the SSL the same as on regular releases.

CALLING IN THE CTI

If the false start condition does not exist, OS relay (SR-1) will be operated and the SSL (FS-1) relay remains normal. The timing continues and a trouble condition is indicated by the calling in of the CTI.

The CTI (FP) relays are connected in a chain circuit to allow only one SSL at a time to gain access to the CTI. More than one SSL may operate its associated CTI (FP) relay but the lowest operated (FP) relay has functional preference and it grounds its "CIA" lead to operate the SSL (CIA) to (CIE) relays.

The (CT) relay does not operate due to the primary and secondary windings opposing each other.

RECORDING INFORMATION

Connecting leads between SSL and CTI operates all the CTI recording relays that have operating paths furnished from the SSL. All the recording relays lock after (GC) and (GC-1) operate.

The (CT) relay is a condenser timed polarized relay. When the (DL) operated ground was closed to the primary and secondary windings. The secondary winding is the strongest and is opposing the primary winding so the (CT) relay is held on its back contact.

The operation of the (TS) opens the secondary winding. The A condenser builds up a charge holding the (CT) relay on its back contact until the surge through the condenser diminishes. Then the primary winding becomes effective and the (CT) operates to the front contact. The time interval is approximately 0.1 seconds and is sufficient to cover the operating and locking time of the recording relays.

RELEASE OF SSL BY CTI

Connection between the trouble indicator and the SSL is now broken. The operation of relay (OS) dismissed, the line link and the SSL circuit restores to normal, due to the further functioning of the timing circuit.

TAKING A TROUBLE INDICATOR RECORD

The LP key is furnished to save unnecessary usage of the display lamps. Operation of LP key operates (BC) relay. (BC) relay operates all lamps whose associated recording relays are locked up.

RELEASE OF THE CTI

Operation of the release key, operates the (IRL) relay and causes circuit action to take place to release the controller trouble indicator.

CTI MADE BUSY (TIB) JACK PLUGGED

A provision is made for making the trouble indicator test busy to any particular SSL control circuit. A jack TIB is furnished and a plug in the TIB jack grounds the "TIB" lead and operates the TIB relay in the associated SSL controller circuit.

When the SSL timing circuit calls for the CTI, the SSL (TIB) relay being operated, the operating path of SSL relay (TI) is open and SSL relay (AR) operates through the normal SSL (TI) relay.

When the (OS) relay operates the "SEL" lead is opened.

The LL releases and all the relays in the SSL release except the (AL), (ON-1), (DPO-4), (TR), (OS) and (TS). The SSL holds itself busy by the (DPO-4) remaining operated to the (ON-1). Then the timing circuit functions as follows:

The (W), (Z) and (WA) relays were operated when the CTI was summoned.

With the release of the (TS) relay, any operated timing relay releases.

This leaves the (TB) and (AR) relays and the AL lamp in an operated position with an audible alarm. Operation of AR key SSL releases this circuit.

SSL FINDS CTI BUSY (ANOTHER SSL HAS DISPLAY RECORDED)

If a trouble display is recorded on the CTI and the SSL in trouble has been released by the CTI and should a second SSL attempt to seize the CTI by operating its (TI) relay, circuit action will be:

+ TI second SSL controller	+ DL CTI + TR Misc. CTI**
+ DL (C nor.) CTI	+ CRL lamp DL locks + AL second controller
+ TR misc. CTI	Locks - CC misc. CTI ¢ major alarm

Circuit action from here on being the same as described for "CTI made busy." (+ AL SSL etc.)

CTI FAILS TO RELEASE SSL

If the trouble indicator fails to supply ground to the RA lead which operates the SSL (AL) relay to release the LL and SSL, then timing will continue. To operate the (AR) and (TB) relays in SSL causing circuit action to take place that will release the (ON1) and (DPO-4) relays in SSL. The SSL controller is now available to handle another call.

USE OF HOLD JACK

When a particular SSL in trouble continues to seize the CTI, a plug may be inserted in the (HD) hold jack of this SSL in order to hold the SSL equipment operated, that is being used by the call. With the equipment operated, as far as the call has progressed, it is easier for the switchman to locate the trouble. When the plug is inserted in the hold jack the SSL (HL) relay operates. When the SSL times out on a trouble condition and after SSL relay (AR) operates, SSL relay (HD) operates. The SSL (HD) relay operated, holds various SSL relays by furnishing holding grounds or locking circuits. Other relays are also held or locked by the relays held by the (HD) relay. Under this condition the line link frame involved will time out and subsequent calls will be served by its mate controller. The SSL will remain out of service and the major alarm will sound. The switchman can proceed to locate the trouble without interference from subscribers calls. The Hold jack should be used with great care due to delaying of calls because 100 district junctors are being held out of service under this condition. Removing the plug from the hold jack releases the (HL) and (HD) relays, silences the major alarm and the operated SSL relays release.

TIMING STAGES

The timing circuit of the SSL control circuit functions from the operation of the CB interrupter as follows:

+ TS Min.	Max.	
0.0 sec.	0.2 sec.	+ W
0.0 sec.	0.5 sec.	+ Z + WA
		- W
0.5 sec.	1.0 sec.	- Z + ZA + TR (traffic release)
		+ W
1.0 sec.	1.5 sec.	+ Z - WA + TA
		- W
1.5 sec.	2.0 sec.	- Z - ZA + FS + FS-1 + AB + RL (false start release)
		+ W
2.0 sec.	2.5 sec.	+ Z + WA + TI (Calling in the control trouble indicator)
		- W
2.5 sec.	3.0 sec.	- Z + TIB + RM-1-4 + AL + TR + OS + AR + aud. alm. + TB + AL Lp.

Trouble indicator fails to release - SSL timing continues. (Relays normal are (W) and (Z), and the relays operated are, (WA), (TI), (TIB), and (AR).

3.0 sec. 3.5 sec.	+ W + Z - TIB - TI
- TI SSL	- Shunt ZA SSL
¢ Int.	- W SSL (holds Z)
- Int.	- Z SSL
- Z	+ ZA SSL
+ ZA	- TR SSL
- TR	- OS SSL
¢ Int.	+ W SSL
- Int.	+ Z SSL
+ Z	Shunts & - WA SSL
- WA	- AL - ON-1
- ON-1	- TS
- TS	Releases all operated timing relays.

CHAPTER 2

SECTION 3

MISCELLANEOUS INFORMATION AND FEATURES

MARCH 1954

LINE LINK AND CONTROLLER
SD 25553-01

DISTRICT JUNCTOR GROUP PREFERENCE OS 108-1

The slipping of a group of twenty district junctors to different line link frames is such that it is necessary to have a lockout circuit, whereby certain line link frames because of their location in the chain have first choice over other line link frames on simultaneous calls. For this reason the D relays in Figs. A, B and C are furnished.

It is assumed that a group of twenty district junctors is slipped to line link frames as follows:

Line Link Frame No.	0	3	4	6	10
	Secondary Switch				
Twenty District Junctor Circuits	1 0	5 4	9 8	3 2	7 6
D relay Chain	D-0	D-2	D-4	D-1	D-3
Figure	A	B	B	B	C

It can be seen from the above chart that the group of district junctors multiples to a pair of secondary switches on five different line link frames. Therefore, it is necessary that the chain circuit be wired to the D relays associated with these secondary switches and that the type of wiring shall be as shown in Figs. A, B and C. It is important to note that the D relays in Figs. A, B and C are not representing the D relays on one line link frame, but are representing three different frames.

When two line link frames select the same group of district junctors simultaneously, both D relays operate and lock. Since the SL lead from the sender link frame is chained through the D relays, preference is given to the operated D relay nearest the point where the SL lead enters the first line link frame. The D relay in Fig. A has first choice since the SL lead starts at this figure.

With preference given to the first choice D relay, the second choice circuit, with its D relay still operated and locked, awaits operation of the sender link frame DP relay which removes the ground from TA, TB, RA and RB leads. The disconnection of ground from these leads releases the associated line link controller circuit G relay, which in turn releases the district group circuit D relay. Release of the G relay changes the preference to the next operated G relay and the circuit again functions to operate another D relay, grounding another GP lead.

EARLY RELEASE

Should a subscriber, after starting a call, disconnect before the LS relay operates, the locking circuits for the LT and V relays and the holding circuit for the VE relay are not provided and therefore disconnection can take place as follows:

Line circuit L relay releases.
Controller circuit VE and V relays release in parallel, due to ground being disconnected from ST lead.
Controller circuit LT and RE relays release in parallel, due to ground being disconnected from LT lead.
Class of service CS relay releases.
Line connector HM and LR relays release.
Controller circuit TT relay releases, GP lead to sender link and controller circuit is opened.

The removal of ground from the GP lead causes the sender link and controller circuit to return to normal.

Controller circuit RL relay operates and locks.

The circuit for operating the RL relay is traced as follows: Battery winding of RL relay, break contacts of V relays, make contacts of VP relay, make contacts of S relay, break contacts of VE relay, make contacts of VS relay, break contacts of TT relay, GS lead, make contacts of AC relay to ground.

District group circuit D relay releases.

From this point, release takes place as in a regular call.
If disconnection occurs after relay LE has operated but before any G-relay has operated (because no ground is connected to the TA or TB leads), the RE relay will release and cause the RL relay to operate and lock, this will cause the TT to release and the LA to operate. After the operation of the LA relay, disconnect will take place as in a regular call. Because no G relay had operated on this call a sender link and controller was not called in. The operating path for the RL is as follows: Battery winding of RL relay, thru break contacts of all G-relays, break contacts of DS and RE relays, make contacts LE and HC-3 relays to ground on break contacts of TRL relay. There is a third early release condition that takes place after the LE and a G relay of the line link and controller have operated, but before the GH relay of the sender link and controller has operated. In this case, release of line link and controller RE relay, prematurely connects ground to the ON lead to the sender link and controller, causing that circuit to advance and connect ground to the RL lead, operating the RL relay of the line link and controller. There is also a fourth condition in the event a terminating call is waiting.
If a terminating marker is waiting to be served and no G relay is operated, the marker can immediately release the controller circuit without waiting for ground on the DK lead from the traffic register circuit, by connecting ground to the LR lead. This ground operates the controller RL relay and disconnects the waiting originating call allowing the terminating call to be served. This feature is ineffective if the sender link frame has detected a trouble condition and has operated the TRC relay.

RELEASE DUE TO PARTIALLY OPERATED LINE RELAY

A line relay L may partially operate and connect ground to its "ST" lead, but not to its associated LT lead. This may occur due to a line leak condition below 10,000 ohms or any other abnormal line condition which does not furnish sufficient current to fully operate the line relay. Partially operated line relay conditions may also be duplicated electrically by dirty LT contacts of any L relay.

The AP relay in the start circuit is furnished for the purpose of immediately identifying any partially operated subscriber line relay. Under normal operation this relay does not have any function.

In all cases of partially operated line relays the controller circuit functions as for a normal call up to and including the operation of the line connector HM and LR relays. Since there is no ground on the LT lead the LT relay can not operate therefore the RE and LS relays remain normal. The LS relay in not operating, prevents the SR relay from releasing in its normal sequence and must now depend upon the operation of the DS relay to cause its release.

When the sender link frame gives preference to this call the line link controller circuit GE relay operates and in turn operates the DS relay. The DS relay in operating causes the SR relay to release which forces the operation of the LS relay. With the LS relay operated a path is closed to operate the LE relay and also connects ground to the LS lead operating the AP relay of the start circuit. The AP relay operated, lights the AL lamp and grounds the AL and A leads.

With this condition existing in the line link controller circuit, the sender link controller circuit functions and ultimately connects ground to the RL lead operating the line link controller RL relay. The RL relay in operating causes the disconnection of the controller and associated circuits.

Each time the line link controller restores to normal the AP relay releases and extinguishes the AL lamp and disconnects ground from the AL and A leads. This arrangement gives an intermitting alarm without requiring the maintenance force to operate the TR restoring key.

If a partially operated line relay is included in simultaneous calls within the same primary switch and column, all fully operated line relays will be served before the controller circuit encounters the partially operated relay.

DELAY TIMING CIRCUIT OS 125-1
MIN. 1.5 SEC. TO MAX. 2.0 SEC.

When the controller circuit HC-2 relay operates on an originating call, ground is supplied to the DM lead of the traffic register circuit. This ground starts a timing circuit to function in the traffic register circuit and after the elapse of approximately one and one-half to two seconds connects ground to the DK lead and operates a traffic register.

If the call is cleared within the normal interval of time, the DS relay operates and removes ground from the DM lead before the time is counted, thereby preventing the connection of ground to the DK lead and the operation of the traffic register.

If the call is not cleared within the normal interval of time and provided that the G-0 to G-9 and DS relays are normal, indicating that no district group selection has been made, ground connected to the DK lead operates the controller circuit RL relay. The RL relay in operating, wipes out the line link circuit. Due to the receiver still being off the hook a new attempt is made on the line link circuit. If there are still no district groups available, the controller circuit continues to operate and release until a group is available. This automatic release is necessary to prevent operating the alarm if an attempt to serve a call is excessively delayed due to a temporary lack of facilities.

When the line link controller is idle, a standing test is applied to the DK lead thru relays LA, LB and FB normal. If there is a false ground on this lead, the operation of the IB interrupter and the TB, TB-1 and TB-2 relays will bring in a trouble alarm.

If a terminating marker is waiting to be served and no G relay is operated, the marker can immediately release the controller circuit without waiting for ground on the DK lead from the traffic register circuit, by connecting ground to the LR lead. This ground operates the controller RL relay and disconnects the waiting originating call allowing the terminating call to be served. This feature is ineffective if the sender link frame has detected a trouble condition and has operated the TRL relay.

TRAFFIC LOCKOUT

On simultaneous originating calls, where more than one HA relay operates, the circuit is arranged to lock out other calls until such time that all groups with operated HA relays have been served. This is accomplished by the GTA relay which in operating opens the start leads to the windings of the HA relays, but does not interfere with their locking leads. In addition, the chain preference on the HA relays progresses from the lowest operated relay to the highest operated relay.

It is assumed that two HA relays operate simultaneously and that the call on the lowest operated HA relay is served. When this call receives its release signal from the sender link frame operating the RL relay and causing the LA relay to operate, the HA relay that was served releases.

When the LA relay releases, the CA relay will continue to lock to the other HA relays that were operated. The CA relay operated will hold the GTA relay. In addition, the release of the LA relay, with the CA relay being held operated, will cause the FA to operate immediately and the next call will be served.

This arrangement allows one call to be served in each horizontal group that originates simultaneous calls, before another call can be served in any of the other groups on the frame. When the last group is served the CA and GTA relays release and restores the operating paths of all HA relays for another registration of waiting calls.

EMERGENCY OPERATION
MIN. 5.0 SEC. TO MAX. 12.0 SEC.

Each two line link frames and their associated controller circuits are arranged to work as mates, so that if trouble develops in the controller circuit of either frame it may continue to serve its subscribers, using the controller circuit of the mate frame. When a controller circuit is working with its own frame it is known as the "Home Controller," but should it be working as an emergency for its mate frame, it is then known as the "Mate Controller." The controller circuits alternate from one frame to the other when working on emergency, so that calls are served on both frames.

When a subscriber starts a call, ground is connected to the armature of the IA interrupter by the operation of the CA relay. Approximately .6 of a second is required to serve a normal call on the line link frame. However, the IA interrupter gives a range of 5 to 12 seconds to free the call, but it requires 6 to 13 seconds to give an alarm. If the call is not served within .6 of a second, the timing circuit functions to free the call involved from the home controller circuit and place subsequent calls in the mate controller circuit. With ground connected to the IA interrupter, the timing circuit functions as follows:

> Start circuit TA relay operates and locks, when IA interrupter B contact closes with the CA relay operated.
> Start circuit TA-1 relay operates and locks.
>
> > When IA interrupter F contact closes, an additional locking circuit is supplied for the TA relay and an additional ground is connected to the IA interrupter, in parallel with the locking circuit of the TA-1 relay.
> > An additional locking circuit is supplied for the GTA relay.
> > An additional locking circuit is supplied for the HA relay.
> > An additional holding circuit is supplied for the horizontal line group circuit H relay.
> >
> > The H and HA relays are held operated so that other waiting calls will be served before the controller circuit is directed back to the group that encountered the trouble.
>
> Start circuit CA and FA relays release.
> Controller connector circuit AC and HC-0 to 3 relays release.
>
> > The release of the AC and HC-0 to 3 relays causes the controller circuit to restore to normal. However, the start circuit HA and GTA relays and the horizontal line group circuit H relay are held operated by the TA-1 relay.
> > At the start of every call the start circuit HA and HB relays are operated together. The HB relay is released by the operation of the H relay as the call is served. If any calls entered the start

circuit simultaneously with the one involved on this failure, their associated HB relays are still operated. Any other calls that originated after the operation of the GTA relay can not operate their associated HA relay. However, the HB relays associated with such groups can be operated, as the GTB relay is normal. Therefore, at this time, there is an HB relay operated for each horizontal line group that is originating a call, except the HB relay of the group involved in the failure. Its start lead is opened at the horizontal line group H relay. When the CA and FA relays of the start circuit released and if the FA relay of the mate frame start circuit is normal (indicating that the mate start circuit is normal) the CB relay operates to ground through the operated contacts of the HB relays. The operation of the CB relay causes the B start circuit to function and connect to the mate controller circuit to serve the waiting calls.

Start circuit TA-2 relay operates and locks.

When IA interrupter B contact closes, ground is disconnected from the IA interrupter.
Start circuit AL lamp lights.
Ground is connected to the A and AL leads.
The ground on the A lead causes an audible alarm to function and the aisle pilot lamp to be lighted.
Ground is connected to the TR lead to the miscellaneous circuit for sender make busy frame.
Ground connected to the TR lead causes a plant register to be scored whenever trouble occurs of such a nature as to cause throw over from the home to the mate frame or vice versa.
Ground is connected to the B contact of the IA interrupter.
This ground holds the TA and TA-1 relays operated until the interrupter opens its B contact.

Start circuit CB relay operates.

If the CB relay has not as yet operated due to the mate controller circuit being busy on a call, the operation of the TA-2 relay will operate it independently of the condition in the mate start or controller circuits provided there is another call waiting with its HB relay operated.
The A start circuit is now out of service and all subsequent calls are cared for by the B start circuit and the mate controller circuit.
The CB relay is a slow operating relay and because of this, the above mentioned operating circuit is supplied. This CB relay can operate while the mate frame is busy on another call. That permits the B start circuit to advance to the point of operating its FB relay when the mate frame completes its present call. The operating circuit of the FA relay of the mate start circuit is traced through the normal contacts of the FB relay of the home start circuit. Likewise, the FB relay of the home start circuit is traced through the normal contacts of the FA relay of the mate start circuit. This arrangement places the FB and FA relays in a chain circuit so that one can not operate unless the other is normal.

The circuit arrangement of the FB and FA relays when combined with the operating path of the CB relay causes the one controller circuit to be alternated between both frames. However, in the event of simultaneous calls the mate frame will be the first to be served, because its CA relay can operate faster than the CB relay of the home start circuit.

Start circuit TA and TA-1 relays release in parallel, when IA interrupter B contact opens.
Start circuit GTA relay releases.
Start circuit HA relay releases.
Horizontal line group circuit H relay releases.

The reason for holding the above three relays operated until this time is to prevent, if possible, the operation of the HB relay associated with the troubled group until after all other waiting groups have been served. Therefore, in most cases the subscribers group involved on a time out will not be served until all other waiting groups have been served.
When the trouble is cleared, the TR key is operated thereby releasing the TA-2 relay and extinguishing the frame AL lamp.

MAJOR ALARM

This alarm consists of the lighting of the MA lamp on the line link frame and the ringing of the major alarm at the floor alarm frame. This accomplished by the operation of the M relay which can operate due to any one or all of the following reasons:

(A) Both controller circuits of a pair of line link frames, arranged to work as mates, are made busy by inserting a make busy plug in each MB jack of both frames. Each MB relay is operated and grounds its AL lead and connects its AL-1 and AL-2 leads together. This results in the operation of the M relay of each frame and the lighting of the MA lamp on each frame in addition to sounding the major alarm.

(B) If a time out occurs while either controller circuit of a pair is made busy two different controls can take place. If the time out is on a frame that is made busy when its TB-1 relay operates its M relay will operate. If the time out occurs on a frame whose mate frame is made busy, the operation of its TA-1 relays will cause its M relay to operate. The M relay in either case performs the functions described above.

(C) If a time out occurs while a plug is inserted in the H jack and the F contact of the IA or IB interrupter closes with the TA or TB relay operated the M relay operates causing the same functions.

Whenever the M relay operates, it locks under control of the TR key. The TR key must be operated in order to release the M relay, extinguish the MA lamp and silence the major alarm.

FRAME TROUBLES

If the timing circuit has timed out and transferred to the mate controller circuit due to a trouble in the home controller circuit, no further time out will occur after the initial time out has taken place. If, however, the trouble was in the frame equipment and a call is blocked after starting through the B side of the start circuit, ground being connected to the IB interrupter when the CB relay operates, causes the TB, TB-1 and TB-2 relays to function as described for the TA, TA-1 and TA-2 relays. The operation of the TB-1 relay, however, opens the locking circuit of the TA-2 relay and restores the A side of the frame to service. Each time a call is blocked a transfer is made from one side of the start circuit to the other.

If a frame trouble or any other trouble is detected by the sender link and controller circuit, it connects ground to lead TRL to operate the controller connector circuit TRL relay which locks to the HC-3 relay if operated and also to the TL lead of the sender make-busy frame. The TRL relay in operating opens the DK lead from the traffic register circuit and grounds the TR lead to the sender make-busy frame. Ground connected to the TR lead operates a trouble register, which removes ground from the TL lead, when fully operated. This register records the number of failures received by the line link frame from the sender link frames. After the sender link frame connects ground to the TRL lead, it removes ground from the SL lead a little later, which allows the line link control circuit GE relay to release and automatically select a new district junctor group to serve the call.

FALSELY OPERATED HG RELAY

Should a horizontal group circuit HG relay remain operated falsely, it connects lead A to lead B, causing the start circuit CA relay to operate in the same manner as an operated HA relay does in a regular call. The controller circuit is called in, as in a regular call, but no column selection can be made, since no line relay in the subgroup is operated. Under this condition a trouble time out occurs.

CHECK FEATURES

During the link release period, checks are made for false grounds on leads, to prevent the controller circuit from being used until cleared of its trouble.

Should the PA relay encounter a foreign ground on any of the leads associated with its winding or its locking circuit during the operation of the controller circuit, it prepares a locking circuit for the RL relay. When the RL relay operates it locks to this ground as long as the PA relay is held operated, thus preventing the controller circuit from releasing. A trouble time out will occur on the next succeeding call due to the failure of the HC-0 to HC-3 relays. On normal operation the PA relay is released before the RL relay operates.

A false ground on lead SA or on any of the contacts 1-B, 2-B, 3-B, 3-T or 4-T of relays HA-0 to HA-9 of the start circuit, or any of the contacts 1-T to 10-T or 1-B to 10-B of relay GTA, or on leads STA-0 to STA-9 of the horizontal line group circuits, would result in a succession of false starts in attempting to serve calls. In any of the above cases it would cause the associated

HA relay either to operate or be locked and make false starts. Hence, the circuit is designed through use of the controller circuit S relay, to detect such trouble ground conditions and prevent the false starts. It is assumed that one of these false grounds is encountered and that the line link starts as in a regular call. The VT relay in operating removes the short-circuit from the S relay, to allow the S relay to operate and lock in the HA relay, after the H relay has operated, removing the ground from the STA and STB leads. Since this false ground will not be removed upon the operation of the H relay, the S relay remains short-circuited, preventing line selection from being made. Under this condition a trouble time out occurs.

A false ground on the line choice connector LO or LE leads to the start circuit would void the use of the lead serving terminating traffic and is detected by the LA or LB relay which operates. This causes an alarm and in the interim the terminating traffic can be served by the LO or LE lead which is not in trouble. When either timing circuit times out and operates its TA-2 or TB-2 relay, the control is transferred to either the A part or the B part of the start circuit. Should an originating call start on the line link frame under these conditions, the CA or CB relay operates, in turn operating the FA or FB relay through operated contacts of the TA-2 or TB-2 relay, thereby serving the call.

When the controller is serving neither originating or terminating calls a standing test applied to the DK lead, through relays LA, LB and FB normal to the winding of relay TB and by the use of the IB interrupter causes a trouble alarm if the lead is falsely grounded.

SECONDARY SWITCH MAKE-BUSY JACKS

Ten jacks, designated SS-0 to SS-9, associated with the start circuit and located on the secondary switch bay of the line link frame, are provided for making the secondary switches busy for maintenance purposes, by making the ten line links associated with a particular secondary switch, busy to originating and terminating traffic.

Insertion of a triple shorted plug in one of these jacks opens the operating circuit for the ten secondary select magnets of the secondary switch. The secondary switch to be made busy corresponds in number to the number of the SS jack used. Only one link will be busy at any one time during the period that the plug is in the make-busy jack, as the HG relays control the link that is involved. For example, if a plug was in the SS-0 jack, making the zero secondary switch busy, a call originating in the zero horizontal line group prevents secondary select magnet zero from operating, while if a call originates in No. 5 horizontal line group the secondary select magnet No. 5 is prevented from operating.

The SS jacks, in addition to opening the operating circuits for the secondary select magnets, also splits the test sleeve of the associated link and grounds the LL lead to the controller circuit and line choice connector circuit. This ground operates the controller circuit T relay corresponding in number to the number of the SS jack as a busy indication, when the controller connector circuit AC relay operates.

HOLD JACK H OS 123-1

The hold jack H, provided in the start circuit, may be used for maintenance purposes to prevent the timing circuit from automatically releasing the controller circuit. This feature is furnished as a maintenance aid so that a call will block at the exact stage where the trouble condition occurred. The location of the line causing the trouble can be determined by the HG, V and LT relays that are operated.

With a triple shorted plug inserted in the H jack, a call timing out causes the start circuit M relay to operate and lock, instead of operating the TA-1 relay or TB-1 relay as already explained under "Emergency Operation." The M relay operated lights the MA lamp and causes the major floor alarm to function. The H jack opens the operating path of the TA-1 and TB-1 relays.

It should be realized that under this condition all lines on the line link frame are "Out-of-Service" and for this reason the H jack should only be used under the closest maintenance supervision and never left unattended.

When the plug is removed from the H jack and the TR key operated, the M relay releases, extinguishing the MA lamp and restoring the frame to service.

EXERCISE JACKS

Exercise jacks EA and EB are furnished in the start circuit as a means of taking the A or B side of the start circuit out-of-service or as a means of routining the B side, to insure that these relays are functioning properly. Otherwise either chain of start relays could be out-of-service without an alarm indication since the working side would automatically serve the call.

A plug in the EA jack opens the operating circuit of the CB relay and prepares the operating path of the CA relay independently of the mate frame. The path for operating the CA relay is as follows: Battery TA-2 relay normal, winding of CA relay, break contacts of CB and LB relays, make contacts of EA jack, make contacts of HA relays, SA lead to break contacts of MB relay, SA-1 lead, break contacts of TA-1 relay, break contacts of TA-2 relay, to TR key ground. A plug in the EB jack opens the operating circuit of the CA relay and prepares the operating path of the CB relay through the mate frame.

If a trouble condition occurs while a plug is in either the EA or EB jack, an alarm is given by the TA-2 or TB-2 relay. Either of these relays operated short-circuits the exercise jack which was being used so that the associated start relays will automatically restore to service. Only one jack should be used on a frame at any one time. If both are used simultaneously neither jack is effective as an exercise jack. The EB jack when used gives terminating traffic the preference over originating traffic when an originating and a terminating call try to use the controller simultaneously. Therefore, this jack should not be used during periods of heavy traffic.

CONTROLLER CIRCUIT MB JACK OS 123-1

A make-busy jack MB is provided to make the controller circuit busy for maintenance purposes, by disabling the A set of start relays on the home frame, and the B set of start relays on the mate frame.

When a triple shorted plug is inserted into the MB jack the MB relay operates. The G lead is grounded at the jack causing the guard lamp on the floor alarm frame to light. This precaution is used since unnecessary delays in dial tone during a busy hour may result while one controller circuit is serving two line link frames.

Closures at the MB relay and at the MB jack contacts prevent calls from going through on the A side of the frame by opening the operating circuits for the FA and CA relays of the home frame and the CB and FB relays of the mate frame. Calls on the home frame are caused to use the B side as an operating path is closed for the CB relay instead of the CA relay. The normal contacts of the CA relay of the home frame that are used to operate the CB relay are short-circuited at contacts of the MB jack, and normal contacts of the CB relay of the mate frame are short-circuited.

Under these conditions a major alarm is sounded if the B side of the home frame or the A side of the mate frame times out. The locking paths of the TB-2 relay of the home frame and of the TA-2 relay of the mate frame are opened so that the circuits are not held out of service if they should time out. A plug in the MB jack of a controller will make a plug in the EA jack of the same controller ineffective, the controller CB relay will operate to serve the calls. Conversely, a plug in the MB jack of a controller will make a plug in the EB jack of the mate controller ineffective, the mate controllers CA relay will operate to serve its calls.

If the MB relays of both frames of a pair are operated simultaneously, a major alarm is given immediately.

RESERVE DISTRICT JUNCTOR GROUP TEST

The purpose of the slow release SR relay is to give the line link frame an opportunity to place calls in those district junctor groups having more than one idle district junctor rather than in those groups having only one available. This is done to reduce the possibility of blocking or delaying calls due to inability to match an idle line link path with a district junctor group having an idle district junctor.

If, in a regular call, there are no groups of district junctors having two circuits idle with idle paths to senders, the subscriber's sender link and controller circuits do not connect ground to any of the TA or TB leads. Consequently, no G relays in the line link controller circuit operate when the TT and VT relays operate nor does the D relay operate when the VS relay operates, thus delaying the connection of ground to the GP lead to the sender link controller circuit.

In this case, release of the SR relay causes the RS and RSA relays to operate. If there are any groups of district junctors with one circuit idle which has an idle path to senders, the associated sender link controller circuit will have connected ground to the RA and RB leads corresponding to these groups. Consequently, operation of the RS and RSA relays causes corresponding G relays to operate. A D relay then operates, advancing the sender link controller circuit as before. The RS and RSA relays release when the DS relay operates.

The SR relay is slow release to allow time for the regular test to take place before the reserve test is started.

In addition, the PA relay in the line link controller circuit is provided to prevent the advance from regular to reserve test should all the sender link frames available to the line link frame be busy. For this reason the PA relay operation depends upon the DA lead grounds from the idle subscriber sender link frames.

Should all frames be busy or no district junctors available the PA relay remains normal under these conditions as the DA leads to the five sender link frames are not grounded. The PA relay normal prevents the release of the SR relay during this interval and insures that the regular test will be made when a sender link frame or district junctors are available.

LINE LOAD CONTROL OS 127-1

The line load control feature is provided for the purpose of giving preference to lines essential to national and public welfare during periods of emergency where an unusually large number of subscribers may attempt to use their telephone facilities.

In order to insure adequate service, the lines on each line link frame are divided into three classes A, B and C. The line load control relays B and C in Fig. 18 are provided for lines in class B and C only. These relays are controlled from a central point by means of the line load control circuit.

When either a B or C relay operates it opens the start leads associated with the line relays within one column; returns a ground on the AB or AC lead respectively and operates the next succeeding B or C relay in the Fig. 18 chain, by grounding the B or C lead. The last B or C relay to operate in the chain grounds the LB or LC lead respectively to the line load control circuit indicating the chain of relays is completed.

The major alarm sounds when a B or C relay operates as a result of a grounded lead or other trouble condition. This alarm is controlled at the line load control circuit.

SUBSCRIBER SENDER LINK AND CONTROLLER
SD 25554-01

RESERVE SENDER GROUP TEST

If a call is routed to a sender link frame having no subgroups with two or more senders idle, and consequently there is no ground on any of the ten GT leads at the time regular sender group test is made, no controller circuit SG relays will be operated.

The line link frame functions and connects ground to the A or B lead which allows district junctor selection to take place. District junctor selection causes the operation of the DS relay which, in turn, operates the sender link controller circuit R-1 and R-2 relays. The operation of the DS relay indicates that an interval has elapsed which would normally be sufficient to complete the regular sender group selection.

The operation of the R-1 and R-2 relays starts the reserve sender group test by disconnecting the ten controller circuit SG-0 to SG-9 relays respectively from the GT leads and connecting them to the ten RT leads associated with the ten subgroups of senders. Ground on an RT lead indicates one sender idle in a subgroup of ten, with an idle link available.

With the RT leads closed, the associated SG relays operate if the leads are grounded, and the controller circuit continues as in a regular call.

FAILURE OF SLEEVE CONTINUITY TEST OS 114-1, 124-1

The controller circuit SL relay is used to check the continuity of the established link connection before the sender is allowed to proceed with the call.

In a regular call when the primary switch A and B hold magnets operate and close the crosspoints, the same ground that operates them is extended over the link sleeve to operate the C and D hold magnets. When the C and D hold magnets have closed their crosspoints, the S lead ground is again extended to the sender and returns on the SL lead to the controller circuit operating the SL relay. Should the SL relay fail to operate on the continuity test, the call will be blocked and the sender link controller circuit times out and gives an alarm.

If a plug is in the HD jack when a continuity test failure occurs, the HD relay will be operated because of the time-out, thus lighting the CF lamp and indicating the failure.

DOUBLE CONNECTION TEST FAILURE OS 114-1, 124-1

The controller circuit DC relay is used to detect double connections; that is, any trouble condition which may have caused the call that is being established to be crossed with an already established connection at any of the switches of the sender link frame.

Double connection test follows after the sleeve continuity test. It is assumed that the SL relay has operated properly for sleeve test. When the SL relay operates, it short-circuits the primary winding of the DC relay and releases the OH relay.

The OH relay, while operated, closed the ground which caused the operation of the SL relay and by opening its contacts in releasing should remove the short circuit from the primary winding of the DC relay, allowing the DC relay to operate. But should the sleeve be crossed with another sleeve of its own switch or another switch on the frame, the primary winding of the DC relay remains short-circuited after the OH relay is released, preventing the DC relay from operating.

The DC relay failing to operate causes the controller circuit to time-out, give an alarm and seize the trouble indicator. This trouble may or may not repeat, but should it keep repeating, the HD jack can be used to hold the trouble on its next appearance. With the hold jack in use and the HL relay operated, on the next time-out of the frame the HD relay operates and lights the DC lamp, indicating a double connection failure. This indication is not absolute since other troubles such as an open DR relay winding will cause the same reaction.

The double connection test will not detect double connections between two idle sender links and is not capable of detecting double connections on the B and D switches, unless corresponding double connections with a busy sender link occur on the A and C switches.

FALSE STARTS - CALL ABANDONED BEFORE GH OPERATES

If the calling subscriber disconnects before the sender link frame has completed its functions, it is considered a false start. False starts are divided into two conditions, controlled by whether or not the GH relay is operated. The first condition is to be considered at this time.

If the calling subscriber disconnects before the sender link controller circuit GH relay is operated, the line relay L in releasing, releases the line link controller circuit RE relay which, if the LE relay in that circuit is operated, prematurely grounds the ON lead to the sender link controller circuit, causing the following:

Controller circuit AB relay operates.
Due to ground on ON lead and GH and SL relays normal, controller circuit RL relay operates.
District group circuit CA relay operates.
District group circuit CB relay operates.

> The line link controller circuit, having received the group end signal (ground SL lead) when the sender link frame was selected, continues to function and connect ground to the A or B lead. When the DS relay operates, the following takes place:

Ground is connected to the line link controller circuit RL lead.

> Ground connected to the RL lead operates the line link controller circuit RL relay, returning the controller circuit and associated line link equipment to normal and disconnecting ground from the A or B leads.
>
> The sender link controller circuit RL relay in operating disconnects the control circuit and associated equipment removing ground from the line link SL lead.

TIMING CIRCUIT

The purpose of the timing circuit is to time each call in order to dismiss the calling line link and controller circuit or the automatic district junctor test frame within a short interval, if the delay is due to a traffic condition, or after a longer interval if a trouble condition is encountered. It also serves to record the number of such trouble conditions and operate a minor or major alarm each time that such condition occurs.

This timing cycle is divided into four stages, as follows:

	*Time Intervals in Seconds	
	Min.	Max.
Pickup	0	0.5
Automatic Release Due to Traffic Delays	0.5	1.0
False Starts - Call Abandoned After GH Operates	1.5	2.0
Sender Link Alarm	2.0	2.5
Additional Timing For Delay After Sender Link Alarm		1.0
Additional Timing For Release When Trouble Indicator Release Fails		2.0

*Measured from seizure of circuit but disregarding relay operating times and interrupter variations.

PICKUP - MIN. 0 SEC. TO MAX. 0.5 SEC.

When the sender link controller circuit is selected by a line link controller circuit and the TS relay operates, the timing circuit functions as follows:

Controller circuit TS relay operates.
Controller circuit TL relay is short-circuited.
Battery is connected to the winding of the controller circuit, W, WA, Z and ZA relays.
Controller W relay operates and locks, when CB interrupter B contact closes.
Controller circuit Z relay is short-circuited.
Controller circuit Z relay operates, when CB interrupter B contact opens.
Controller circuit WA relay operates and locks.

The operation of the above timing relays is considered the pickup period for the timing circuit. This means that when the TS relay operates, if the CB interrupter is at the point where the B contact is going to open but there is just enough time for the W relay to operate and lock, then when the B contact does open the Z relay immediately operates, thus giving a minimum time period.

The fraction of time used from the B contact is so small that it is considered zero time. If when the TS relay operates, the B contact of the CB interrupter has just opened, then it means that the complete open period of the interrupter plus the full time period for the closure of the B contact constitutes the maximum period or 0.5 of a second.
From here on, each release cycle and each operate cycle for the W and Z relays will add 0.5 of a second to the minimum and maximum pickup time.

AUTOMATIC RELEASE DUE TO TRAFFIC DELAYS
MIN. 0.5 SEC. TO MAX. 1.0 SEC.

It is assumed that a traffic delay has occurred due to no sender groups available after the reserve sender group test has been made. All SG relays will be released. The timing circuit having completed its pickup will continue to time as follows:

Controller circuit W relay is short-circuited and releases, when the CB interrupter B contact closes.
Controller circuit Z relay is held operated.
Controller circuit Z relay releases, when the CB interrupter B contact opens.
Controller circuit ZA relay operates.
Ground is connected to the SLT lead to the traffic release control circuit.

The SLT relay does not operate at this time due to the 1340 ohm SLT resistance included in this path.
When the ZA relay operates during a traffic delay due to all sender subgroups being busy, the following occurs:

Controller circuit TR relay operates.
The ST lead to the district junctor test frame is opened.
Controller circuit OS relay operates.
The SEL lead to the line link controller circuit is opened.
Holding ground is connected to the controller circuit ON-1 relay.

Ground being disconnected from the SEL lead causes the line link controller circuit GE relay and the selected G relay to release. This causes the line link district group circuit D relay to release and disconnect ground from the GP lead of the sender link frame, releasing the GP relay. The GP relay in releasing will cause the sender link frame to disconnect and release the TS relay which will release the timing circuit.
The line link controller circuit GE relay and the selected G relay in releasing cause a new group selection to be made. This call may reenter the same sender link controller circuit or it may select another circuit to serve it. Whenever the sender link controller circuit is unduly delayed, in sender group selection, it will automatically dismiss the calling line link controller circuit or the automatic test circuit and restore to normal in order to prevent false trouble alarms due to traffic delays. Such dismissals will occur very rarely since ordinarily the interval required for sender group selection is very short.

FALSE STARTS - CALL ABANDONED AFTER GH OPERATES
MIN. 1.5 SEC. TO MAX. 2.0 SEC.

It has already been explained that a disconnect occurring before the GH relay operates is registered in the line circuit on the line link frame. If the calling subscriber disconnects after the GH relay operates, the abandoned call can not be recognized until the sender circuit has progressed to the point where it tests the closure of the tip and ring before applying dial tone. This is due to the fact that the sender link frame has practically finished its functions in the call.

This circuit is not capable of detecting the difference between a trouble condition wherein the tip or ring, or both conductors through the switches of the established connection are actually open, and a normal false start call in which the tip and ring conductors are closed momentarily to start a call and then immediately opened by the calling subscriber as in an abandoned call. However, a register is provided for recording all such conditions since it is expected that the majority of legitimate false starts will consist of closures longer than one second in duration, so that a trouble register record will furnish a fair indication of the existence of actual trouble conditions. By comparing the register readings for all sender link controllers periodically, those registers which record a predominance of false starts will indicate the presence of actual trouble in the tip and ring conductors in the associated sender link frame.

On this type of false start, it is assumed that there was no traffic delay and that an SG relay was operated and a sender selected for serving the call. The timing circuit will have functioned operating the ZA relay. The timing circuit now continues to time, as follows:

Controller circuit W relay operates and locks, when CB interrupter B contact closes.
Controller circuit Z relay is short-circuited.
Controller circuit Z relay operates, when CB interrupter B contact opens.
Controller circuit WA relay releases.
Controller circuit TA relay operates and locks.
Controller circuit W relay is short-circuited and releases, when CB interrupter B contact closes.
Controller circuit Z relay is held operated.
Controller circuit Z relay releases, when CB interrupter B contact opens.
Controller circuit ZA relay releases.

> At this point of the timing circuit, when the ZA relay releases, more than enough time has elapsed for a normal call to be served, for which the tip and ring closure has been recognized by the sender. If the circuit has not released prior to this time, it is assumed that a "false start after GH operates" has occurred, although actually some trouble condition may have caused the same reaction. In any case there will be very few possible trouble conditions, other than an open tip or ring, which can exist at this point in such a way that the circuit will be permitted to restore to normal without being indicated by operating an audible alarm.

For the purpose of this text, it is assumed that a false start exists when the ZA relay releases causing the circuit to function as follows:

Controller circuit FS relay operates.

The FS relay can not operate at this time unless the DR relay is operated, indicating that the call has progressed to the point where it is the function of the subscriber sender to operate the AB relay. The AB relay can not operate normally for this abandoned condition because of the tip and ring not being closed to the sender.

Ground is connected to the FS lead to the miscellaneous circuit for sender make busy frame.
Controller circuit FS-1 relay operates, from ground or battery on the GS lead.

The operating circuit for the FS-1 relay is wired as a potentiometer for the purpose of insuring that the FS-1 relay operates whether or not the sender circuit has had time to operate the ON-2 relay. Therefore, the operating circuit for the FS-1 relay will be from ground or battery on the GS lead, from the sender SR-1 relay released or battery from the winding of the sender ON-2 relay with the SR-1 relay operated, respectively. This is to prevent a false start from registering as a sender link alarm. Such conditions that can prevent the ON-2 relay from operating are as follows:

(a) Flashing by the originating subscriber at such time as to delay the operation of the sender L and SR-1 relays and, thereby, to make these relays encroach upon the operating time of the sender ON-2 relay. Thus the timing circuit would pass on into the alarm stage.
(b) Plug fumbling on the part of the PBX attendant who originates a call. The effect is the same.

Ground is connected to the line link controller circuit RL lead.

Ground connected to the RL lead operates the line link controller RL relay returning the controller circuit and associated equipment to normal.
The sender link controller RL relay in operating disconnects the controller and associated equipment as in a regular call. The FS relay releases when the DR relay releases. The FS-1 relay will release from the release of the sender SC-1 relay.

Controller circuit AB relay operates and locks.
District group circuit CA relay operates.
District group circuit CB relay operates.
Controller circuit RL relay operates.

SENDER LINK ALARM
MIN. 2.0 SEC. TO MAX. 2.5 SEC.

Should the sender link frame fail to release when dismissed by the line link frame due to a frame trouble, after having completed a regular call or after a traffic release due to a traffic delay or after a false start, the controller timing circuit would have functioned. Thus, due to the sender link frame not releasing, the controller timing circuit continues to time as follows, to calls in the trouble indicator.

Controller circuit W relay operates and locks, when CB interrupter B contact closes.
Controller circuit Z relay is short-circuited.
Controller circuit Z relay operates, when CB interrupter B contact opens.
Controller circuit WA relay operates and locks.

TIME-OUT WITH TROUBLE INDICATOR MADE BUSY
ADDITIONAL 1.0 SEC. OF TIMING

If the trouble indicator for the sender link controller has been made busy, the controller circuit TIB relay will have been operated over the TIB lead from the trouble indicator frame. When the WA relay operates, the following takes place:

Controller circuit AR relay operates and locks, because TIB relay is operated.
Ground is connected to the G and LA leads of the floor alarm frame.

Ground being connected to the LA lead causes a minor audible alarm but should a plug be in the HD jack, a major audible alarm is given since the MA lead will be grounded instead of the LA lead.

Controller circuit TB relay operates.
Controller circuit AL lamp lights and in parallel ground is connected to AL lead to the miscellaneous circuit for trouble indicator frame.
Controller circuit AL relay operates and ground is connected to the line link circuit TRL lead in parallel.

Ground connected to the line link TRL lead causes the line link controller circuit TRL relay to operate. If a test call is being made by the automatic district junctor test frame and the TRL lead is grounded, it will dismiss the test frame call on a trouble release basis.

Operates the ON-1 relay if not operated at this time or holds it operated if already operated.
Holding ground is connected to the controller circuit TB relay.
Ground is connected to the TR lead of the miscellaneous circuit for the sender make busy frame.

Ground connected to the TR lead scores the trouble register for the associated controller circuit.

Ground is connected to the district group circuit CA and CB relays.

> The AL relay holds the CA and CB relays if operated at this time, but if they have been released due to the line link disconnecting ground from the A or B lead they reoperate when the AL relay operates.

Ground is connected to the GS lead.

> This ground can only be connected to the GS lead if relay SL is operated in order to permit connections to be established if the DR relay fails to operate. It also provides for the operation of the sender ON-2 relay which will make the sender busy as long as its S lead remains grounded.

Controller circuit TR relay operates.
Controller circuit OS relay operates.
The SEL lead to line link frame is opened.

> The opening of the SEL lead toward the line link frame releases the GE relay and the preferred G relay thereby allowing the line link frame to seek the services of another sender link frame. By the release of the G relay, the associated district group relays release and thereby disconnect ground from the GP lead toward the sender link frame. With the line link frame dismissed, an additional 1.0 second is counted while the sender link frame is held busy to allow sufficient time for the line link controller circuit that encountered the trouble condition to be routed to another sender link frame for a second trial. Therefore, the controller timing circuit continues to count time as follows:

Controller circuit W relay is short-circuited and releases, when CB interrupter B contact closes.
Controller circuit Z relay releases, when CB interrupter B contact opens.
Controller circuit ZA relay operates.
Controller circuit TR relay releases.
Controller circuit OS relay releases.
Controller circuit W relay operates and locks, when CB interrupter B contact closes.
Controller circuit Z relay is short-circuited.
Controller circuit Z relay operates, when CB interrupter B contact opens.
Controller circuit WA relay releases.

> By this time, it is assumed that the line link frame has disconnected itself from this sender link frame restoring those relays under its control. This will include the release of the ON relay and the OC, DS, SL relays if operated.

Controller circuit AL and ON-1 relays release.
Controller circuit TS and DP-0 to 4 relays release.
Controller circuit W, Z and ZA relays release.
Controller circuit TA relay releases.

When the sender link alarm is answered and the AR key operated, the AR and TB relays are released and the AL lamp extinguished.

TIME-OUT WITH TROUBLE INDICATOR IDLE

If the trouble indicator is idle, then when the WA relay operates, the following takes place:

Controller circuit TI relay operates.
Battery through 226 ohm resistance is connected to the TIS lead to the trouble indicator circuit.
Ground is connected to the DL lead to the trouble indicator circuit.

The operation of the TI relay and its connection of battery to the TIS lead is for calling in the trouble indicator.
When the trouble indicator is selected it takes a record of certain relay information and locks it in for a lamp display on the trouble indicator, and then connects ground to the RA lead for disconnection.
If when the TI relay operates, should the trouble indicator be busy with another sender link controller, this controller is delayed momentarily until the trouble indicator circuit connects ground to all the RA leads for disconnection.
When ground is connected to the RA lead for either of the above conditions, the circuit functions as follows:

Controller circuit AL relay operates and ground is connected to the line link circuit TRL lead in parallel.
Operates the ON-1 relay if not operated at this time or locks to it if operated.
Ground is connected to the TR lead of the miscellaneous circuit for sender make busy frame.

Ground connected to the TR lead scores the trouble register for the associated controller circuit.

Ground is connected to the district group circuit CA and CB relays.

The AL relay holds the CA and CB relays if operated at this time, but if they have been released due to the line link disconnecting ground from the A or B leads, they reoperate when the AL relay operates.

Ground is connected to the GS lead.

This ground can only be connected to the GS lead if relay SL is operated in order to permit connections to be established if the DR relay fails to operate. It also provides for the operation of the ON-2 relay in the sender which will make the sender busy as long as its S lead remains grounded.

Controller circuit TB relay operates.
Controller circuit TR relay operates.
Controller circuit TI relay releases.
Controller circuit OS relay operates.
SEL lead to line link is opened.

> At this point, the sender link controller timing circuit continues to count time for an additional 1.0 second.

TROUBLE INDICATOR FAILS TO GIVE RELEASE SIGNAL ADDITIONAL 2.0 SEC. OF TIMING

If the trouble indicator fails altogether to supply releasing ground to the RA lead, the sender link controller timing circuit continues to time for 2.0 additional seconds, during which it gives an alarm, guards itself for a moment, and then disconnects itself from the trouble indicator.

When the trouble indicator is called in, the timing has functioned, the W, Z and WA relays having been operated. The timing circuit thus continues to time, causing the following:

Controller circuit W relay is short-circuited and releases, when CB interrupter B contact closes.
Controller circuit Z relay releases, when CB interrupter B contact opens.

> The ZA relay can not operate at this time because of a short-circuit provided by the TI relay being operated.

Controller circuit TIB relay operates.
Locking circuit is connected to TI relay.
Ground is connected to RM lead to the trouble indicator.

> The connection of ground to the trouble indicator RM lead operates the relay which ordinarily grounds the RA lead, if not already operated. This relay then locks. This places the trouble indicator in an off-normal condition so as to save delays and prevent alarms on other sender link frames. If ground is now received on the RA lead, the AL relay operates immediately. But this text assumes that ground is still missing on the RA lead.

Controller circuit AR relay operates and locks.
Controller circuit TB relay operates.

> The operation of the TB relay causes the circuit to function. The timing circuit continues as follows:

Controller circuit W relay operates and locks, when CB interrupter B contact closes.
Controller circuit Z relay is short-circuited.
Controller circuit Z relay operates, when CB interrupter B contact opens.

Under normal operation of the timing circuit, the WA relay should release at this time, but since the ZA relay was prevented from operating during the previous .5 second of timing, the WA relay remains operated.

Controller circuit TIB relay releases.
Controller circuit TI relay releases.
Battery is disconnected from the TIS lead to the trouble indicator circuit.

The disconnection of battery from the TIS lead to the trouble indicator circuit allows it to release from the sender link controller. The timing circuit continues to time as follows:

Controller circuit W relay is short-circuited and releases, when CB interrupter B contact closes.
Controller circuit Z relay is held operated.
Controller circuit Z relay releases, when CB interrupter B contact opens.
Controller circuit ZA relay operates.
Controller circuit TR relay releases.
Controller circuit OS relay releases.
Controller circuit W relay operates and locks, when CB interrupter B contact closes.
Controller circuit Z relay is short-circuited.
Controller circuit Z relay operates, when CB interrupter B contact opens.
Controller circuit WA relay releases.

The controller circuit releases.

TRAFFIC RELEASE CONTROL FEATURE

The traffic release control feature (Fig. 16) is for the purpose of improving the timing circuit "Automatic Release Due to Traffic Delays," under the following conditions:

(a) If all senders are busy in a subgroup in high peaks of traffic long enough to have the timing circuit complete its first stage of timing and operate its ZA relay.

(b) In any period of traffic should two or more sender link controllers simultaneously have timed past the point where relays ZA or TA are operated.

CONDITION (a) - SENDER SUBGROUP BUSY

The SGB relay operates when all senders of the associated subgroup become busy, and since traffic is fairly well distributed over the various subgroups, the operation of relay SGB on any subgroup may be taken as an indication of a peak sender load.

In high peaks of traffic when all senders in the office are busy and during this period if only one sender becomes available at one time, there is a race between sender link controllers for its selection. This might cause an interruption in the timing traffic release circuit in controllers seeking these idle senders by the repeated operation and release of relays SG-0 to 9 on successive tests for the idle sender subgroups. This would allow the timing circuit to continue to time beyond the traffic release period and register a false trouble alarm, the timing period being 1.5 seconds between the two conditions.

In order, therefore, to prevent interruption of the traffic release path in various controllers due to successive operations of relays SG-0 to 9 under this condition, the control circuit (Fig. 16) is used to alter the traffic release during high peaks of traffic.

When the MB chain on the SB-0 to 9 relays is closed, due to all senders being busy in the subgroup, the following takes place:

> Sender selector circuit SGB relay operates.
>
> > The SGB relay can also be operated from the MB jack at the sender make busy frame.
>
> The associated GT lead from the SB-0 to 9 relays is opened from the SGB relay and connected to the LL lead to the sender make busy frame.
> Ground is connected to the BL lead to the sender make busy frame.
> Ground is connected to the CG lead to the traffic register circuit.
>
> > Ground connected to the BL and CG leads lights a sender group busy lamp on the sender make busy frame and operates a traffic register respectively.
>
> Sender subgroup busy circuit GB-0 to 9 relays, one on each associated sender link frame operates.
>
> > Associated with each sender link frame are ten GB relays, designated No. 0 to No. 9, each relay representing one sender subgroup on the frame. The purpose of a GB relay when operated, is to open the five preference leads PA, one to each district group circuit, thereby, taking away the availability of this sender subgroup.
>
> Traffic release control circuit SGL relay operates.
> Traffic release control circuit GS relay operates and locks.
> Ground is connected to the CG leads for sender link frames No. 0 to No. 8 and to the emergency controller.
> Traffic release control circuit GS-1 relay operates and locks.
> Ground is connected to the CG leads for sender link frames No. 9 to No. 19.
>
> > The SGL relay is common for all sender link frames, therefore, as long as there is one sender subgroup registering on all senders busy condition, ground is maintained on the CG leads.

With this condition existing, now each time a sender link controller times out for traffic releases, the ZA relay in operating causes the following:

Controller circuit SS-1 relay and the SS relay operate in series.
Due to the ZA relay being operated with ground on the CG lead, when reserve sender group selection has not taken place.

The SS-1 relay, in operating, connects ground directly for operating the TR relay, independent of the series circuit through the released contacts of the SG-0 to 9 relays. This insures that the traffic release takes effect, even though an SG- relay should operate after the ZA relay is up, but before the TR relay has had time to operate. The SS-1 relay also opens the operating path for the OC relay, preventing its false operation should an SG- relay operate before the TR relay.
If sender group selection is completed within the allotted interval, when ground is existing on the CG lead, the SS-1 relay will be short-circuited by the operating ground for the SS relay.
When the traffic peak subsides and there is no ground on the SGL lead from any subgroup of senders, the following takes place:

Traffic release control circuit SGL relay releases, when ground is removed from SGL lead.
Traffic release control circuit TT relay operates and locks, when LT interrupter F contact closes.
Traffic release control circuit LCR relay operates and locks, when LT interrupter B contact closes.
Traffic release control circuit GS and GS-1 relays release, when LT interrupter B contact opens.

Any SS-1 relay that is operated at this time due to not having been shunted down by the operating ground for the SS relay, now releases by the removal of ground from the CG leads when the GS and GS-1 relays release.
The SS-1 relay in releasing, causes the controller circuit to revert again to the traffic release path through the SG-0 to 9 relays. This path is better adapted for detecting such troubles as an open circuit, in the operating path of the LL relay or the LL ground chain or the winding of the SS relay.

Traffic release control circuit TT relay releases, when LT interrupter B contact opens.
Traffic release control circuit LCR relay releases.

The LT interrupter cycle for release of the traffic release control circuit is 28 seconds minimum to 58 seconds maximum.

CONDITION (b) - SIMULTANEOUS TIME-OUTS BY CONTROLLERS

The sender subgroups need not reach a point where all senders in any one group are busy before calls will be delayed sufficiently at the sender link and controller circuits to cause time-outs which needlessly call in the trouble indicator and give an alarm. To avoid this situation, the traffic release control feature is arranged to function when two or more sender link controllers simultaneously have timed passed the point where relays ZA or TA are operated.

When each sender link and controller has either the ZA or TA relay operated, it grounds the SLT lead through a 1340 ohm SLT resistance. The presence of two or more 1340 ohm ground closures on lead SLT causes the SLT relay to operate causing the traffic release control feature to function.

SENDER SUBGROUP TROUBLE

When no calls are being placed in a sender subgroup by a sender link controller, relays CH-1 and CH-2 are normally operated if the two contact chains on the LL- relays are closed through. If either of these chains should be defective and incomplete, relay CH-1 would release, releasing relay CH-2 or relay CH-2 would release alone. Since no call is being placed in the subgroup, the C relays associated with this subgroup are released thus permitting relay CH-2 to release. When relay CH-2 is released, it operates the CH-3 relay which places ground on the TB lead through all the LL- relays in the chain to the MB lead operating the SGB relay. This makes the subgroup busy to all controllers and provides a signal to the miscellaneous circuit for the sender make busy frame, where a minor alarm is indicated.

If there should be no LL- relay contact trouble but a trouble in the controller or subgroup circuit between the time the LL- relay is operated and the C relay associated operates, relay CH-2 will release operating relay CH-3. Since an LL- relay is operated the MB lead is not grounded at this time. The controller will time-out and call in the trouble indicator providing a record of the subgroup and controller involved in the call. When the trouble indicator has recorded the information or if the indicator is busy, the TIB lead is grounded by the trouble indicator which operates the SGB relay, making the subgroup busy until the unserved line link frame has had a chance to select another subgroup via another sender link frame.

The SGB relay in operating for either of the above trouble conditions, functions as already described.

EMERGENCY TRANSFER SWITCHES

There is only one emergency controller circuit in an office for use on any sender link frame, should it be necessary to remove the regular controller from service due to trouble or when it is desired to adjust any relays in the regular controller. In order to transfer to the emergency controller, the A and B switches should be restored to normal and the associated emergency controller switches A and B should be operated. Each sender link frame has an EM lamp, which when lighted indicates that the emergency controller is being used.

When the emergency A switch is closed the EL lead is grounded, lighting the EF and EC lamps in parallel and the EC relay operates in series. The EC relay operated lights the EM lamps. The EF lamp is individual to the frame and when lighted indicates that this frame is using the emergency controller. The EC lamp is also individual for its frame and are centralized in an emergency lamp panel located at a central point for observation. The EM lamp lights on every frame and indicates that the emergency controller is in use.

USE OF HOLD JACK TO INDICATE TROUBLE

This circuit is so designed as to be of assistance to the maintenance force in observing repeated troubles after their detection by the trouble indicator. By this method, the available idle district, the sender subgroup and the selected sender, are obtained, depending of course, upon the extent to which the call has progressed at the time that a trouble condition has been encountered. The indications mentioned are only obtained when a trouble condition is encountered after a plug has been inserted in the HD jack. Since this condition requires that the controller circuit be out of service during the interval that the trouble is being observed, it is important that the HD jack shall be used only under close maintenance supervision and never be left unattended. As long as the circuit is held out of service by the HD jack at the time of trouble, the associated 100 district junctors and the selected group of ten senders are also held out of service with no busy indications or other means for diverting traffic.

When the plug is inserted into the HD jack, a circuit is closed to operate and lock the HL relay. The HL relay in operating opens the release path to the TRL lead and the operating path for the AL relay. With the HL relay operated, the sender link frame will still function as before, except that when the next trouble appears, a release can not be effective.

Upon the appearance of a trouble, the timing circuit, in timing out, calls in the trouble indicator for a record of the trouble. At this point, the timing circuit TA, W, Z and WA relays are operated. The trouble indicator then grounds the RA lead but this has no effect because of the HL relay being operated. Therefore, the timing circuit continues to time for .5 of a second causing the W and Z relays to release. Upon the release of the Z relay, the following occurs:

Controller circuit TIB relay operates, controller circuit TI relay locks.
Controller circuit AR relay operates and locks.
Controller circuit HD and TB relays operate in parallel.
Controller circuit operated GP relay locks.
Controller circuit OC relay holds.
Controller circuit ON relay holds.
Controller circuit CF lamp lights, if trouble is continuity failure.
Controller circuit DC lamp lights, if trouble is double connect failure.
Controller circuit AL lamp lights.
Ground is connected to the line link TRL lead and sender link controller circuit AL relay operates in parallel.

With the HL relay operated at the time that the AL relay operates, the TR relay can not operate, therefore, the SEL lead ground is not opened. This will cause the line link controller circuit to time-out and connect to its mate emergency controller circuit, thus indicating the line link frame involved on the connection.
The timing circuit continues to time for another .5 of a second operating the W and Z relays. When the Z relay operates, it releases the TIB and TI relays, allowing the trouble indicator to release.
The sender link controller circuit GP relay locked in, will indicate the group of twenty district junctors selected for the call, and it holds the controller relays operated in the same manner as in service.
The maintenance procedure then would be to first record the sender subgroup by the operated SG- relay. This information will serve to indicate the sender subgroup location in the secondary switches, after which, a check for the operated secondary select magnet will indicate the particular sender in the subgroup. After these records are taken, the regular controller circuit should be disconnected from the sender link frame and the emergency connected to restore service provided, of course, that the emergency is not being used by another frame.
When the A and B switches for the regular controller are restored to normal, the district junctor and sender group controller relays release. With the transfer made to the emergency controller, the sender link frame and its 100 district junctors are available again for service while the regular is being investigated for trouble.
The plug should be removed from the HD jack to release the HL relay and restore the circuit to normal.

COMMON HOLD JACK

The common hold jack feature is used for a trouble condition that is affecting all frames, and it can not be certain as to which frame it will involve. It is designed to lock-in the trouble condition on its first appearance, regardless of which frame it first affected.

When the common hold jack feature is in use, there should be no plug in the individual HD jack. If there is, the circuit will operate for the individual hold jack and disregard the common hold jack.

When a plug is inserted into the common hold jack H, the following takes place:

Common hold jack circuit A relay operates, from battery on the sleeve of common hold jack H.
Common hold jack circuit A-1 and A-2 relays operate in parallel.
Controller circuit HL relays operate and lock, from ground on their individual H leads.

The HL relays of those sender link frames which have calls in progress do not have an operating circuit until their TS relay releases. Upon the next release of the TS relay on these frames, their HL relays operate and lock.

Minor alarm LA lead is opened and major alarm MA lead is closed. Operating path for TR relay is opened.

The common hold jack circuit has now prepared all sender link controllers for a lock-in of the next time alarm regardless of which frame it now appears on.
Assuming now that the timing circuit for someone of the controllers results in a time alarm. The controller AR relay in operating, causes the following:

Controller circuit HD and TB relays operate in parallel.

The HD and TB relays perform the same functions when using the frame hold jack and in addition the following:

Ground is connected to the common hold jack circuit HT interrupter and the C relay operates if the B contact is closed.
Common hold jack circuit B relay operates.
An additional locking circuit is connected to the controller circuit HL relay on only the sender link frame having the time alarm.
Common hold jack circuit HD lamp lights.
Common hold jack circuit A relay releases.
Common hold jack circuit A-1 and A-2 relays release in parallel.
Controller circuit HL relays release on all frames not having a time alarm, due to ground being disconnected from the H leads to all frames.

The HR key is provided at the sender link frames for the purpose of releasing a time alarm and the controller involved, when using the common hold jack. Should the AR key be operated instead only the alarm will be silenced, but the controller will remain out of service.
A timing circuit is provided in the common hold jack circuit to give a major alarm and to light lamp HD, should a false ground be encountered on the L lead or the failure of the B relay to operate or the failure of any of the circuit relays to release. To release this alarm an HT key is provided.

DISTRICT GROUP CIRCUIT MB JACK

A make busy jack MB is furnished for each district group circuit, which may be used for removing a group of twenty district junctors from service, or for adjusting any of the associated relays, as well as any of the primary switches.

When a plug is inserted into an MB jack, the shunting circuit for the CA and CB relays is opened and the DP relay is operated. The DP relay operated removes ground from the TA, TB, RA and RB leads indicating no district junctors idle in the group to the associated line link frames.

TEST CIRCUIT CALLS

When the district junctor automatic test frame desires to have a district junctor connected to a subscriber sender for test purposes, it connects battery to one of the D-0 to D-9 leads, ground to one of the G-0 to G-9 leads and battery to the start lead, causing the following to take place:

Controller circuit TL relay operates, if no regular call is being served at this time.

The TL relay in operating opens the operating path of the GP relays, preventing the frame from being seized by line link frames.

Controller circuit RS relay operates.
Controller circuit DE relay operates.
Controller circuit TS relay operates, timing circuit is connected for operation.
Controller circuit OS relay operates, the SEL lead to the line link frame is opened.
Controller circuit ON-1 relay operates.
District group circuit DP-0 to DP-4 relays operate, ground is removed from all TA, TB, RA and RB leads.
Controller circuit TC relay operates.
District group circuit DA or DB relay operates.

The operation of a DA or DB relay closes through ten district junctor circuits to the controller circuit.

District group circuit G relay operates, ground is connected to a CS-0 to CS-7 lead.

The district group circuit G relay in operating causes a sender group selection to take place as in a regular call.

Controller circuit ON relay operates.
Controller circuit TD relay operates, connects the D-0 to D-9 relays to test frame.
Battery is connected to the SGT punching.

The SGT punching is cross-connected to one of the punchings SG-0 to SG-9 to distribute as desired the sender group preferred on test calls.

Controller circuit TE relay operates.

From this point on the circuit functions as on a regular call, except that ground will be connected to the ON lead of the sender when the GH relay operates and the sleeve continuity check thru the line link controller is cancelled by ground being placed on the H lead when the TE relay operated. The double connection test is made as in a regular call. When the RL relay operates, it connects ground to the RL lead of the test frame which recognizes the release signal and disconnects. Should a trouble condition occur on a test call while a hold plug is in the hold jack, the test circuit will automatically disconnect after it receives a trouble release signal on the TRL lead.

LOAD CONTROL - SENDER PREFERENCE CANCELING

Where the originating office unit is arranged for sender load control, the LC relay operates from the traffic register circuit when load control becomes effective. Relay LC in operating opens the SP leads from the different district group circuits, each of which gives a different preference starting point in the selected sender subgroup and grounds only the SP-0 lead to the sender subgroup. This insures that the first nine senders of a subgroup will receive first preference, since the last choice sender of each subgroup under these conditions is arranged to automatically route calls to overflow and is therefore to be last preferred.

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CHAPTER 3

SECTION 1

PURPOSE, DESCRIPTION AND FUNCTIONS

Subscriber Sender SD-25012-01

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DESCRIPTION AND FUNCTIONS

GENERAL

This section covers the detailed circuit operations of the subscriber's sender from the recording of dial pulses to sender release. It consists of various steps that are devoted to the discussion of the senders operation for the different types of calls. Sender selection by the subscriber's sender link and controller, registration of class of service and district frame number in the sender was covered in Chapter 2.

SUBSCRIBER SENDER FRAME

PURPOSE

The purpose of the subscriber's sender is mainly to record the office code and number dialed by the subscriber and then to use this information to direct the building of a connection to the called subscriber's line. The sender is arranged to work with coin and non-coin lines and to make or cancel two-party test depending upon the setting of the class of service relays.

The sender is designed to perform many different functions among which are the following:

To register the class of service of the calling line and the district frame through which the call is coming.

If the class registration indicates that the call is from a two-party message rate line to determine whether the tip or the ring party is calling.

To send dial tone to the subscriber as soon as the circuit is ready to record the dial pulses.

To register a permanent signal in case the first dial pull is not registered within 40 seconds after the sender is seized.

To absorb one or more preliminary pulses caused by accidental movement of the switchhook before dialing.

To register 2 or 3 digits of the office code and 4 or 5 digits of the numerical code of the called number.

To establish connection with an originating marker through an originating marker connector.

To send to the originating marker the class of service, to which the calling line is entitled, the number of the district frame involved, and the office code of the called number.

To receive from the originating marker and register all information which the sender requires to complete the connection to the called office.

To guide the selection of a panel type office selector if information from the marker shows it to be in the route to the called point.

On a full selector call, to guide the selections of the panel incoming and final selectors, or crossbar terminating sender, in accordance with the numerical code set up on the dial register.

To transmit the office and numerical code registered to a tandem office or to transmit the numerical code to a PCl position in a manual office.

DESCRIPTION

The originating sender frame RM 1-16 is arranged to mount five originating sender units RM 1-17, which may be either subscriber senders, "A" operator key pulsing senders or a combination of both. The sender units count upward, 0 to 4. Under the subscriber sender link frame, we learned that the subscribers' senders are divided into subgroups of 10 or less senders, but not less that 5; thus normally two adjacent sender frames with a total of ten senders will constitute a sender subgroup.

A subscriber's sender circuit consists of relays and a 100-point 6-wire crossbar switch used to record the called number and district frame number. The key pulsing sender circuit is very similar to the subscriber's sender, except that relays are employed in place of the crossbar switch.

The number of senders required will depend upon the calling rate and the holding time.

Each subscriber's sender is individually connected direct to the sender link frame secondary switches by eight leads, and to the sender selection portion of the sender link controller by four leads. In addition to these, there are 23 other leads which are common to a subgroup of senders which connect to the subscriber's sender link controller for registering district frame indications, the class of service and for control purposes.

The subscriber sender circuit may be divided into several groups of relays depending upon their function as follows:

The general control circuit relays control the connection between the sender and the sender link and control circuit, between the sender and the originating marker and between the sender and the district junctor.

The dial pulse and switchhook control circuit relays receive and count the dial pulses of each digit and provide switchhook supervision at all times except while the sender monitor is connected to the sender.

The office code and number dialed, and the number of the district junctor frame involved are recorded upon the crossbar switch. There is one vertical assigned for the district junctor frame number, two verticals for the "A" digit and one vertical each for the remaining digits of the office code and called party's number. The digits are recorded on the horizontal crosspoints in each vertical as numbered from the bottom 0 to 9. Additional relays are required to record whether the district frame number is below or above ten, to steer the information to the proper vertical for each digit, and to record the class of service of the calling line.

The selection register relays function with the originating marker to record the information which the sender requires in order to do its part in establishing the connection to the called line.

The fundamental circuit relays include those which are required for making fundamental selections, for recording reverse battery or overflow, and for making trunk guard test.

The counting relays are operated in successive pairs by the pulsing of the stepper relay which is energized by the revertive pulses generated by distant panel selectors or by the crossbar terminating sender. The number of pairs operated for a particular selection is determined by the number of pulses required to reach the number dialed.

The selection sequence circuit relays control internal connections in the sender in a definite order as the sender progresses through its successive selections and trunk tests.

The PCI pulsing circuit relays are used to transmit the called number to a manual office in place of the sequence switch as used in panel.

The timing circuit relays measure off the maximum allowed time for the calling subscriber to start dialing, to finish dialing, and for the sender to release. If these times are exceeded, the timing circuit directs the call to the sender monitor so that proper disposition may be made of the call.

FUNCTIONS

When a sender is seized by a sender link and controller circuit to serve a call it immediately registers the class of service to which the calling line is entitled, and the number of the district link frame involved.

The sender is arranged to handle a maximum of twenty-four classes of service. Some of the commonly used non-coin classes of service are unrestricted, restricted or zone registration flat rate, message rate individual, or message rate two-party classes. The commonly used coin classes of service are single slot or multi-slot public, semi-public, or residence classes for either dial tone first or coin first service.

When the sender is arranged to handle more than six classes of service, the class to which the calling subscriber is entitled is registered on two of ten class of service relays CS0 to CS9.

RM 202 shows how the class of service is determined at the line link and passed to the class of service relays in the sender. The class of service is passed on to the originating marker by grounding combinations of five leads depending on the combination of CS (0 to 9) relays operated. The CS (6-9) relays are furnished only when the sender is arranged for more than six classes of service. The CS (6-9) relay operated will indicate one of four groups of six classes and the CS (0-5) will indicate the particular class in the group. The CS6 operated indicates one of classes 1 to 6; the CS7 one of classes 8 to 13; the CS8 one of classes 14 to 19 and the CS9 one of classes 20 to 25. (Class of service 7 is always assigned to key pulsing senders.) Because of the circuit arrangement for the "coin" and "two-party" tests, dial tone first, coin classes must be assigned to relays CS (0-2) and 2MR classes to relays CS (3-5). There are no restrictions is assignment of other classes except that two party flat rate zone registration lines must be considered as two party message rate by the sender. The CS (0-2) and CS (3-5) may not always represent COIN and 2 MR classes, respectively. For example, the CS0 may be arranged so that it will be COIN in all 4 groups of 6 classes or it may represent COIN in the 2 groups controlled by the CS6 and CS8, and any other class except 2MR in the other 2 groups. The CS1 and CS2 may be arranged in the same manner. Similarly the CS (3-5) may represent 2MR in all 4 groups of 6 classes or only in the 2 groups controlled by the CS7 and CS9, and any other class except COIN in the other 2 groups.

The registration of the district frame is required so that this information may be passed on to the marker which must know the district link frame involved in a particular call in order to mark a path back from an office link frame to the desired district link frame. This registration is made on the crossbar register switch vertical designated F and two relays designated (F00) and (F10) RM 3-1.

A ground is received over one of the F0 to F9 leads and the F00 or (F10) lead from the subscriber sender link frame. A grounded F0 to F9 lead indicates the units digit of the frame number of the district group involved. F00 will be grounded if any one of frames 0 to 9 is handling the call and a grounded F10 lead indicates that one of frames numbered 10 to 19 is involved. The sender control relays (SC1) and (SC2) are operated from the sender link and controller circuit through the springs of the (F) hold magnet of the register switch as soon as the sender is seized. The grounded F0 to F9 lead will operate the corresponding select magnet of the crossbar switch. The same ground is passed on to the select magnet auxiliary relay circuit which will cause the operation of the (F) hold magnet of the register switch. The closed crosspoint on the register switch will set up ground indications to the originating marker over four leads on an additive basis. The F10 relay will ground an F10 lead to the marker. The (F00) relay does not pass any information to the marker but serves for making connections used in checking the integrity of other transmitting leads, and furnishes an operating path for one of the select magnet auxiliary relays to insure that the (F) hold magnet does not operate before the proper select magnet has operated. It will be noted that a grounded F0 and a F00 lead does not pass any indication on to the marker. The absence of ground on all of the frame leads indicates to the marker that district link frame 0 is involved in the call. After the district link frame number has been recorded on the register switch, the register advances to the next position so that it will be in position to record the first digit of the office code.

The calling subscriber now receives dial tone, unless the call is from a two-party message rate line, in which case the sender will make a test to determine whether it is the tip or ring party making the call before sending dial tone to the subscriber.

RM 203 shows a condensed circuit schematic of the apparatus involved in making the two-party message rate test and in sending dial tone to the subscriber.

With the closing of the calling line through to a sender, both the T and R leads are connected through the contacts of the (MS) relay normal, (ON1) operated, (ON3) normal and (CS4) operated to the winding of a tip party relay (TP) which will operate to ground through the subset ringer in case the tip party of a two-party message rate line is calling. If a ring party is calling the line will be free from ground and the (TP) relay will not be operated.

When the class of service relay (CS4) assigned to handle two-party message rate calls operated, a condenser timed polarized relay (TPT) was energized. The delayed action of the (TPT) relay allows time for the (TP) relay to operate if the tip party is calling, setting up the marker to handle a tip party message rate call. When the (TPT) relay operated ground was extended from the (ON1) relay through the (CS4) and (TPT) relays to operate the (ON3) relay. The tip of the calling line is then connected to ground through a tone repeating coil and the ring of the line is extended to battery through the winding of the line relay (L) which operates. The subscriber now receives dial tone.

Should a flat rate or individual message rate line be calling there is no need for the sender to determine which party is calling as there is no distinction to be made between message registers on either side of the line. The class of service relay assigned for this type of call has no connection to the (TP) relay therefore the tip party test will be cancelled and the (ON3) relay will operate over its secondary winding to send dial tone to the subscriber. As soon as the sender has registered the class of service, district frame number and tip party indication, the sender link and controller circuit is released and the established connection is then under control of the sender.

The subscriber is now ready to start dialing. The dial register, consisting of a 100 point 6 wire crossbar switch, registers all of the digits dialed which will consist of a maximum of three office code digits and five numerical digits or four numerical digits and a party letter. As previously explained, the number of the district link frame involved in the call is also registered on this switch.

A condensed schematic of the apparatus used in counting the dial pulses and registering the dialed digits is shown in RM 204.

The crossbar switch has ten verticals, designated, (F) for the district frame involved, (A) and (AA) for the first digit of the office code (B) for the second and (C) for the third digit of the office code, (TH), (H), (T), (U) for the thousands, hundreds, tens and units digits of the numerical code, and (ST) for the fifth numerical number or party letter.

The line relay operates when the T and R of the calling line are extended to it and remains operated except for a momentary release on each dial pulse or when the subscriber hangs up to abandon the call. On the first operation of the line relay dial tone is closed through to the line.

At the first open and closure of the line for each digit dialed pulse counting relay (P1) is operated and locked in. This registers the first pulse dialed on the pulse counting relays. On the second line open and closure at the dial, pulse counting relay (P2) is operated which releases pulse counting relay (P1). This registers the second pulse dialed on the pulse counting relays. The pulse counting relays operate in sequence with the pulses dialed and remain operated after each pulse as tabulated on the next page:

Pulse	Pulse Counting Relays	Operating Crossbar Switch Select Magnet
1	P1	1 (After "AA" Register has operated)
2	P2	2
3	P3	3
4	P4	4
5	P5	5
6	P5 & P6	6
7	P1 & P6	7
8	P2 & P6	8
9	P3 & P6	9
10	P4 & P6	10

The pulses of each digit dialed are counted on pulse relays (P1) to (P6). Each pulse relay operates in rotation and locks until released by the operation of another, or by the operation of the crossbar switch register advance circuit after it has recorded the digit dialed.

When the digit "O" is dialed, the first five pulses operate pulse relays (P1) to (P5) respectively and each (P) relay as it operates, releases the one preceding it. The sixth pulse operates (P6) which locks in during the remainder of the digit, but does not release (P5). The seventh pulse operates pulse relay (P1) again and that releases (P5). The eighth, ninth and tenth pulses operate pulse relays (P2), (P3) and (P4) respectively, each pulse relay as it operates releases the one ahead of it. At the end of the ten pulses sent by the dialing of digit "O", pulse relays (P4) and (P6), corresponding to the digit "O" dialed, are operated and locked in.

In case an accidental pulse is sent by the subscribers switchhook before the first pull of the dial, or if number 1 is pulled in error for the first digit, the line and pulse counting relays operate and release as for any legitimate digit, but no select magnet on the dial register will operate because the operating path from pulse counting relay (P1) to the number 1 select magnet is not closed until after the registration of the first digit (other than digit number 1) which closes some cross-point of the (AA) register. Whenever one or more preliminary pulses corresponding to the digit number 1 are dialed, the dial register will not operate to record these accidental pulses, nor is the registering process advanced so as to register the first legitimate digit on the (B) register. Any number of preliminary pulses will be absorbed in the same way, provided they come far enough apart to allow the relays mentioned to release between pulses. Otherwise, they will register as a 2 or higher number and the (A) and (AA) register will operate.

An exception to the above case will occur when the sender is arranged for handling calls into an extended area by registering the digits one-one before the digits for the regular office code are registered. The use of this arrangement is restricted to outlying suburban areas which wish to dial direct into a large metropolitan area. An example of the application of this feature might be found in offices of various towns on Long Island which provide for dialing one-one to get a routing to a trunk into New York City. With this arrangement the sender will absorb only one preliminary pulse. Two preliminary pulses spaced far enough apart to cause the sender to interpret them as digits will be registered on three auxiliary relays furnished in the path to the (A) and (AA) registers.

The presence of dial tone on the line is an indication to the subscriber that no digits have been registered.

As soon as the district link frame indication has been set-up on the (F) register, it advances the register so that when the first digit of the office code is dialed the (A) register will operate and in turn advance the register to receive and register the second digit of the office code.

At the end of the first string of pulses the register switch select magnet (except number 1) corresponding to the pulse counting relay or relays locked in will operate, but not before the frame hold magent (F) has been properly operated by the district link frame indication. (See Fig. 8D). The Select magnet operated causes the hold magnets to operate the (A) and (AA) dial register. With the (AA) register operated the digit 1 when dialed as a digit subsequent to the first digit dialed will now operate the registers.

The hold magnets (A) and (AA) close the contacts of the (A) and (AA) registers at the cross-point established by the operation of the select magnet corresponding to the number of the digit dialed. Hold magent (AA) operated also closes a circuit to cut off the dial tone from the line.

As many digits as may be dialed, after the first, are registered in the same way on the succeeding registers. There is no further restriction against registering a digit 1.

After the three digits of the office code have been dialed operating the (A), (B) and (C) registers the register advances to receive the thousandths, hundredths, tens, units and party digits of the numerical code.

The sender is arranged to record either a 2 or 3 digit office code. The first digit dialed operates the (A) and (AA) register as previously described. If the first digit dialed indicates a 2-digit office code, the (AA) register records this indication, and the second digit causes the operation of the (C) register, by-passing the (B) register. In case a 3-digit office code is dialed the (AA) register indication is such that the second digit of the 3-digit office code operates the (B) register.

The numerical digits are registered on the "TH" (thousands). "H" (hundreds), "T" (tens) and "U" (units) and the party station or the fifth numerical digit if any is registered on the "ST" (station) register.

As soon as the office code, or the digits of a special service code have been registered, the sender connects to an originating marker through an originating marker connector circuit and transmits the office code, class of service and number of the district link frame involved to the marker. If the call is of the message rate two-party class an additional indication will be transmitted to the marker if the call is from the tip party.

In case the first digit is not dialed a timing circuit will function to operate a permanent signal (PS) relay which will ground the A1 and A4 leads to the marker. When the sender recognizes a permanent signal condition, connection is established with the marker and this information is passed to the marker which will proceed to establish a connection with an operator.

The various items of information are transferred to the marker by grounding a selection of leads to the marker in such a way that all leads employed in the transmission of information are checked for opens, grounds and crosses, and all unused transmitting leads are checked for grounds and crosses. Should any trouble be encountered on these leads, the marker is prevented from functioning on the call and is released from the sender.

The marker proceeds to decode the various items of information it has received and transmits back to the sender the selection information required to establish the connections in the called office. When the marker has sent its selection information to the sender the originating marker connector is released breaking all direct connections between the sender and the marker.

The sender is still in indirect communication with the marker through the sender link and district junctor. When the marker has completed its function of establishing a connection from the district junctor through the district and office link frames, it signals the sender to proceed with its work.

If the first marker encounters trouble in receiving information from the sender, in decoding, in transmitting information to the sender, or in selecting an outgoing trunk to the desired point not due to an all trunks busy condition, it will send a ground back to the sender over the trouble release lead, thereby releasing the marker connector and breaking all direct connections between the sender and marker.

Likewise, if the marker encounters a trouble condition when trying to establish connection to a chosen idle trunk after its direct connection with the sender through the marker connector has been broken it will send a trouble release signal through the district link frame and sender link frame for a moment only. The sender will release all selection register relays set up by the marker and make a second connection through the marker connector to another marker.

This may be the same marker as before but usually will be a different one, since the first marker holds itself busy momentarily after sending a trouble release. The sender upon the second trial, grounds the alternate route lead "AR" notifying the second trial marker to use the alternate route to the desired point, if there is one available. In all other respects, the second trial marker will try to establish the connection in the same manner as the first marker.

During the brief time between the first and second trial with the markers the connections set up on the district link frame are released, allowing that frame to start afresh on the second trial.

If the second trial marker encounters one of the conditions previously described as preventing the first marker from routing the call, the trouble release lead will be momentarily grounded a second time, releasing the marker connector, breaking all direct connections with the marker. With the marker released the sender releases all the selection relays set up by the marker for routing the call and again operates the marker connector, which connects the sender with a third trial marker. The sender upon the third trial, grounds lead OF to the third trial marker thus notifying it to establish connection to an overflow trunk, which routes the call to an all trunks busy tone.

For a brief time between a second and a third trial with the markers, the connections set up on the district link frame are released, allowing that frame to start afresh on the third trial.

If the third trial marker encounters any of the conditions which cause a retrial, the trouble release lead will be grounded a third time releasing the marker connector, if still engaged. A false indication is then set up in the district junctor to place it in the talking condition and the sender is released and restored to normal. Even though no connection has been made to an outgoing trunk the junctor will hold until the calling subscriber disconnects.

If no trouble is encountered in the transmitting leads or in the decoding portion of the marker, operation selection information will be sent back to the sender.

The marker transmits selection information to the sender by grounding a selection of leads to operate the correspondingly designated selection register relays in the sender. ✓

The selection register circuit is set up by the marker to record the class of call, the compensating resistances required in the fundamental circuit, the distant office selections, if any are required, and other details of the routing which the sender requires, to do its part in establishing a connection to the called station.

In general, the calls handled by the sender will fall in one of the following classes:

Full selector to panel office
Full selector to crossbar office
Restricted code routed direct to operator
PCl tandem
PCl direct
Official code, special service, vacant code and permanent signal.

The compensating resistance inserted in the fundamental circuit will be either 0, 300, 600 or 900 ohms depending upon the requirements of the trunk circuit in the distant office.

The distant office selection information is required only when the call is routed through a panel office selector frame and consists of office brush and office group selections required to establish a connection to a trunk into the called office.

A station delay (SD) indication is given to the sender to indicate that the called office is one which has numbers requiring a possible fifth numerical digit or a station letter and that it should delay the continuation if its functions until after the subscriber has had sufficient time to dial the additional digit.

With this information set up on the selection register relays the sender releases the direct connection with the marker through the originating marker connector and awaits a signal from the marker via the district link, district junctor and sender link, indicating that an outgoing trunk has been selected and a connection established through the district link and office link frames to the distant office.

The sender is then ready to proceed with its functions of directing the distant office equipment in establishing a connection to the called station.

The sender directs the equipment in the distant office by counting revertive pulses sent from the distant office, or by transmitting panel call indicator (PCl) pulses to the distant office.

RM 3-2 shows the disposition of the office and numerical codes on the various class of calls.

On full selector calls (crossbar to panel office) or (crossbar to crossbar office) the sender stepper relay is energized by revertive pulses generated by distant panel selectors or by the crossbar terminating sender. Revertive pulses sent from distant panel office selectors will operate the stepper relay over an equivalent 24 miles (2700 ohms) of standard cable. Revertive pulses sent from a crossbar terminating sender will operate the stepper relay over an equivalent 32 miles (2900 ohms) of standard cable. Thus, it is the terminating equipment which determines the direct dialing range of the subscriber sender.

Counting relays are operated and locked up in successive pairs by the pulsing of the stepper relay. The number of pairs operated for a particular selection is determined by the number of pulses required for the number dialed, or by the operation of the selection register relays.

On a call routed through a panel office selector frame the sequence of the various selections is as follows:

Office test
Office brush selection
Office group selection
Trunk test
Incoming brush selection
Incoming group selection
Final brush selection
Final tens selection
Final units selection
Incoming advance.

If there is no panel office selector in the train the first three stages are omitted and trunk test becomes the first stage. On a call through a panel office selector the marker establishes a connection to the distant office selector. The sender directs the office selections through the office selector to a trunk to the called office.

The sender makes a test of the trunk to insure that it is in condition for use, in accordance with the class of call indication received from the marker. Trunk test is made immediately following the office selections, or upon receipt of a signal that the marker has established a connection through the local office link frame if no office selections are to be made, unless it is delayed by one of the following conditions:

(a) On a full selector call to a panel office, the thousands digit must be registered.

(b) On a full selector call to a crossbar office, the hundreds digit must be registered and the first pulse of the tens digit received.

(c) On any PCl or operator class call dialing must be completed.

RM 3-3 shows the relation between the numerical code dialed and the incoming brush, incoming group, final brush, final tens and final units selections on the incoming and final frames in a panel office.

RM 205 shows in schematic form the progression through the selections by counting revertive pulses from a panel office. The counting relays are set in position to start counting from the number required as determined by the number set upon the register switch. Each successive pulse operates a lower numbered counting relay until counting relay (0) is operated, which in turn operates the break (BO) relay. (BO) breaks the fundamental circuit to stop the distant circuit in its advance.

The fundamental is held open between selections long enough to prevent a false secondary closure on the preceding selection or a premature closure on the succeeding selection. On starting the final brush selection the fundamental circuit is momentarily closed through a high resistance to discharge the trunk conductors. Incoming brush selections follow trunk test at once, incoming group awaits the registration of the hundreds digit if it has not been registered, final brush follows incoming group at once, final tens awaits registration of the tens digit, and final units awaits the registration of the units digit.

On calls using common incoming trunks in a multi-office terminating unit the sender will count the normal number of pulses for incoming group selection for one of the offices and will add five pulses to incoming group selection for the other office that is reached over the common trunk group.

After the incoming advance selection on a full selector call has been made, or the sending of pulses on a PCl call has been completed, or trunk test on an operator class call has been made, the sender will signal the district junctor to assume its cut through position, and then return to normal and disconnect itself by releasing the sender link.

On PCl tandem and PCl direct classes of calls the equipment in the distant office is set up by call indicator pulses sent out by the subscriber sender.

When the sender connects with the trunk to a PCl tandem office, it waits for the trunk assignment with a trunk guard relay held operated in the fundamental circuit. The operated trunk guard relay informs the pulse generating circuit to prepare itself for the transmission of PCl pulses. After the trunk is assigned at the distant end, the trunk guard relay releases causing the transmission of PCl pulses to the Call Indicator office through the same compensating resistances as were used in the trunk test.

The sender now proceeds to transmit the office code according to the setting of the (A), (B), and (C) dial registers unless the code is of two digits only, when the pulses are transmitted according to the setting of the (A) and (C) dial registers.

Following the transmission of the office code on a tandem call, the sender transmits a possible five digits of the numerical code according to the setting of the stations (ST) thousandths (TH) hundredths (H), tens (T), and units (U) on the dial register. In the case of a PCl direct (not through tandem) call, the numerical code only is transmitted in the same manner.

If the called number is under 10,000 the pulses are transmitted in the order named above with the party letter digit (ST) transmitted between the last office code digit (C) and the first digit of the numerical code (TH). If the called number is over 10,000 then the station (ST) digit (being a fifth numerical digit) is sent after the units digit (U) instead of before the thousandths digit (TH). A digit zero is transmitted in place of a party letter or fifth numerical digit if no party letter or an impossible five digit number was dialed.

Since the crossbar impulses must work into the same equipment in the manual office as the panel impulser, the same types and combinations of pulses are used. Each digit of a number is transmitted by a set of four pulses. The second and fourth pulses are always formed by grounding the tip conductor of the fundamental circuit and connecting battery through a 6500 or 115 ohm resistance to the ring conductor. The first and third pulses are formed by grounding the ring conductor and either connecting battery through a 6500 ohm resistance to the tip conductor or leaving the tip side open. A single pulse with the ring grounded and battery through a 115 ohm resistance on the tip conductor is transmitted at the end of each series to indicate the end of the code.

These pulses are called light or heavy negative, light or heavy positive and blank pulses. The following table shows the condtions imposed on the tip and ring conductors for each type of pulse.

Type of Pulse		Tip	Ring
Light negative	(n)	grd.	6500^{W} Battery
Heavy negative	(N)	grd.	115^{W} Battery
Light positive	(p)	6500^{W} Battery	Ground
Blank	(-)	-	Ground
Heavy positive	(P)	115^{W} Battery	Ground

RM 206 shows the call indicator impulser circuit used in the crossbar subscriber sender.

These pulses are generated by a condenser timed interrupter circuit consisting of a non-biased polarized relay and a timing network.

The pulse generating relay is so polarized that when battery is connected to the plus and ground to the minus terminals of the primary winding, the armature moves to contact 1 and when the current is reversed in the primary winding, the armature moves to contact 2. Considering only the primary winding and disregarding the ground connection through the (C1) relay, the armature of the (PG) relay would move rapidly back and forth. The secondary winding, and condenser, however, provide a pulse of current controlled in duration by the size of the condenser, that opposes the effect of the current in the primary winding.

With the armature against contact 2, as shown, the primary winding tends to pull it to 1, but the reverse pulse due to the action of charging the condenser delays its action for a short interval. When the armature does move to contact 1, the action of the primary winding tends to move it to contact 2, but the discharge current of the condenser delays this action for a short interval. The continual repetition of this sequence of operation provides the required interrupter action. The ground through the (C1) relay holds the (PG) relay energized with the armature against contact 2 when the fundamental circuit is not cut in to the impulser circuit.

The average operating time of the pulse generator relay in generating PC1 pulses is about .07 seconds per single operation.

(PG1), (PG2) and (PG3) are auxiliary pulse generating relays. (PG1) operates every time that (PG) is on its back contact and grounds the FR lead for a blank or light positive pulse. In its normal position it places ground on the FT lead for a light or heavy negative pulse. Each complete cycle, which generates four pulses to transmit one digit proceeds as follows:

Pulse	PG1	PG2	PG3
1	Operated	Operated	Normal
2	Normal	Operated	Operated
3	Operated	Normal	Operated
4	Normal	Normal	Normal

The winding of (PT) is connected to lead 1 of the dial register when (PG3) is normal and to lead 3 when (PG3) is operated. The winding of (PR) is connected to lead 4 of the dial register when (PG2) is normal and to lead 2 when (PG2) is operated. The (PT) and (PR) relays are operated during the pulse preceding the one they are to control. The leads from the dial register are grounding or not according to the setting of the cross-points of the register switch for each digit in accordance with the combination of pulses required for that digit.

The different combinations of four pulses determine the numeral transmitted for each digit. Each negative pulse, whether light or heavy, serves to advance the distant control circuit which receives the pulses and registers the number transmitted. A heavy positive pulse is generated at the end of the units series of pulses to indicate completion of pulsing for the called number.

Three different codes of pulse combinations are used, the regular one for the office code and all numerals, except thousands; the thousands code, and the station code. These codes are given in the following table where n represents a light negative pulse, N heavy negative, p light positive and - a blank pulse. The four letters J, M, R and W corresponding to numerals 5, 6 7 and 9 are the only station designations provided for. If no station designation is dialed or if any other numeral is dialed in error, a zero will be transmitted.

Regular	Thousands	Stations
0 - n - n	0 - n - n	0-- n - n
1 p n - n	1 - n - N	1 p n - n
2 - N - n	2 p n - n	
3 p N - n	3 p n - N	
4 - n p n	4 - N - n	
5 - n - N	5 - N - N	5 (J) - n p n
6 p n - N	6 p N - n	6 (M) - n - N
7 - N - N	7 p N - N	7 (R) p N - n
8 p N - N	8 - n p n	
9 - n p N	9 - n p N	9 (W) - N - n

When a call is routed direct (not through tandem) the process of transmitting pulses is the same as for a tandem call, except that the office code recorded on the (A), (B) and (C) dial register is not sent and the numerical code pulsing starts on the (ST) or the (TH) register, depending on whether the called number is under or over 10,000. With this type of PCl call, the dial progress relays associated with the office code are operated in advance by the marker and the leads at the dial register cross-points are advanced to cancel the transmitting of the office code, allowing the station number only to be sent.

If the tandem offices are arranged to receive only 3 digit office codes, any 2 digit code dialed is transmitted as a 3 digit code by interposing a zero between the 2 digits dialed. The progress through the dial registers is the same as if a 3 digit code were dialed, but as nothing is registered on the (B) register, a zero is transmitted for the second digit.

After the sender has released, the path of the call in the originating office through the line link, district junctor, district link and office link frames is under control of the district junctor circuit.

BRIEF REVIEW OF CHAPTER 2

The operation of the (S) relay in the sender select circuit caused the (SCl) and (SC2) relays in the subscriber's sender to operate and further identified the sender by operating the secondary select magnets on the sender link frame. The (SCl) relays in the sender close through the class of service and frame leads causing the operation of one of the (CS) relays 0 to 5 and either the (CS6) or (CS7) and for frame registration either the (F00) or (F10) relay and one of the select magnets 0 to 9 on the sender register switch. The two class of service relays operated and either the (F00) relay lock up for the duration of the call, but the select magnet releases after it has caused the operation of the (F) hold magnet, with the aid of the (SM1), (SM2) and (SM3) relays. Class of service and frame registration is then checked by the (CK) relay. If more than one (CS) relay 0 to 5 is operated or both (CS6) and (CS7) or both (F00) or (F10) or two crosspoints closed on the (F) vertical unit of the register switch, the (CK) relay will operate and cause the sender link frame to time out and release the sender. The normal (CK) relay, therefore, indicates that class of service and district frame registration have been properly recorded. The sender link and line link controllers proceed to close crosspoints on the primary and secondary switches of the sender link and line link frames. This action connects the tip and ring of the subscriber's line through to the sender and also closes other leads through to the district junctor. This being an individual class of service call, the sender cancels two-party test and causes the (ON3) relay to operate.

The register control circuit in the sender used for recording the district frame number on the crossbar register switch, prepares to record the first dialed digit by operating the (RA1), (RA2), (RA3), and (RA4) relays and releasing the (SM1), (SM2) and (SM3) relays. The operation of the (RA4) relay closes a path to operate the (ON1). The (ON1) relay closes the tip and ring through to operate the (L) relay. Should the tip or ring be open, the (L) relay will not operate causing the sender link controller to time out and release the sender. No alarm is given on this type of failure, but the condition is noted by operating a false start register associated with the sender link frame. If the (L) relay operates, it operates (L1) and (SR). The (SR) sends dial tone to the subscriber and operates the (SR1). The (SR1) operates the (L2) and (ON2). The operation of the (ON2) closes a ground to the "S" lead to hold the crosspoints and sends a release signal to the sender link controller causing its release. The release of the sender link controller causes the line link controller to release.

At this point in the call, the following relays and hold magnets are operated:

LH and DH (Hold) - Line Link Frame
A, B, C, and D (Hold) - Subscriber's Sender Link Frame
F (Hold)
(FOO), (CSO), (CS6), (ON1), (ON2),
(ON3), (L), (L1), (L2), (SR), (SR1), - Subscriber's Sender
(RA1), (RA2), (RA3), (RA4), (AV3) and
(OF2) (operate from off-normal ground)
S1 - District Junctor
SB - Sender Select Circuit

DIAL PULSES

Electrical Bias of (L) Relay

The primary winding of the (L) relay is its operating winding and is connected in series with the line at this time. The tertiary winding, to which ground is connected by operation of the (ON-1) relay, provides an electrical bias for the relay. This electrical bias compensates for variations in the voltage of the central office battery, as any increase or decrease in the magnetic field set up by the operating (primary) winding due to a change in voltage, is counter-balanced by a corresponding increase or decrease in the opposing tertiary winding. With this circuit arrangement, there is always approximately the same relation between these two windings, and the operating and releasing properties of the relay are in consequence, not materially affected by fluctuations in voltage.

The electrical bias also causes the relay to be "power driven down" on a small reduction in its operating current. For example, if the operating winding provides 100 ampere turns and the biasing winding 90, a drop of only 15 per cent in the line current leaves the current in the bias circuit stronger by 5 ampere turns, forcing the relay to release.

Secondary Winding of (L) Relay

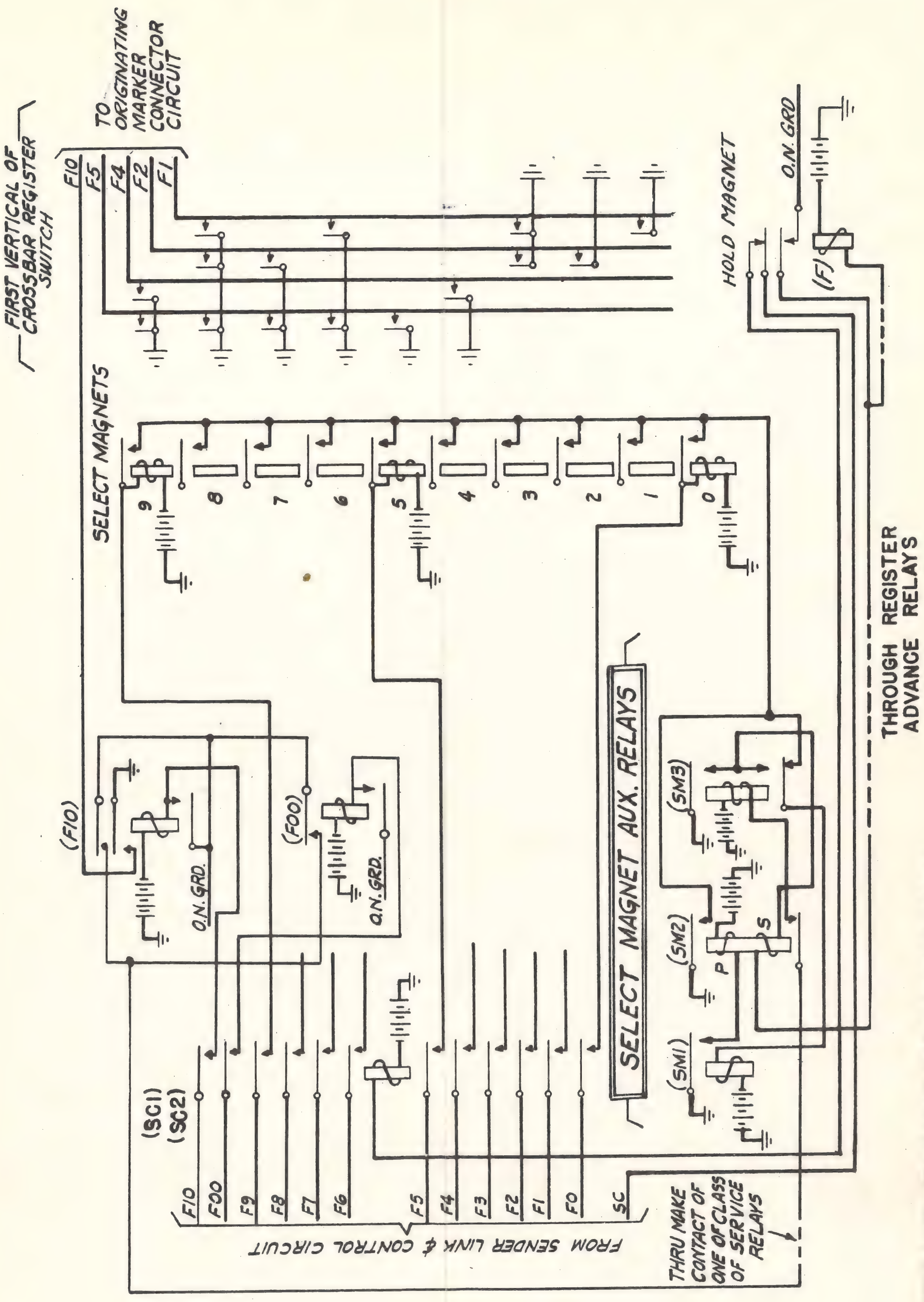
The secondary winding of the (L) relay, in a circuit with the (PH) condenser, insures a minimum of front contact closure of .012 second and a minimum back contact closure of .009 second, regardless of the percentage make and break of the dial contacts. These two extremes, of course, do not occur in the same dial pulse.

The minimum front contact closure is provided by the charging current of the (PH) condenser, after the relay operates, from battery through the secondary winding of the (L) relay, to ground through the winding of the (L1) relay and operated contacts of the (L) relay. This charging current is in the operate direction of the (L) relay and tends to hold it operated until the condenser becomes fully charged, even if the path through the primary winding should be opened before that time.

The minimum back contact closure is provided by the discharge of the (PH) condenser, this action starting as the relay breaks its front contact in releasing. In order to illustrate this action, the charged condenser may be considered as a small storage battery having a very short life, and with the front contact of the relay open, disconnecting ground from this portion of the circuit, the batteries at the (L) and (SR) relays have no effect on the circuit as their ground return is open. The fact that the batteries are common, however, and therefore connected, is of use in tracing the discharge circuit. It originates at the right plate of the (PH) condenser, which has a positive charge, and is traced through the winding of the (SR) relay and the DD resistance in parallel, to the battery symbols, thence over the battery bus bar to the battery symbol at the secondary winding of the (L) relay, through this winding to the left plate of the condenser which has a negative charge. This discharge current is in the release direction of the (L) relay. It assists the biasing winding in making the relay fast release and tends to hold its back contact closed until the condenser is fully discharged, even if the operate winding should be energized again before that time, due to a line surge.

DB Condenser

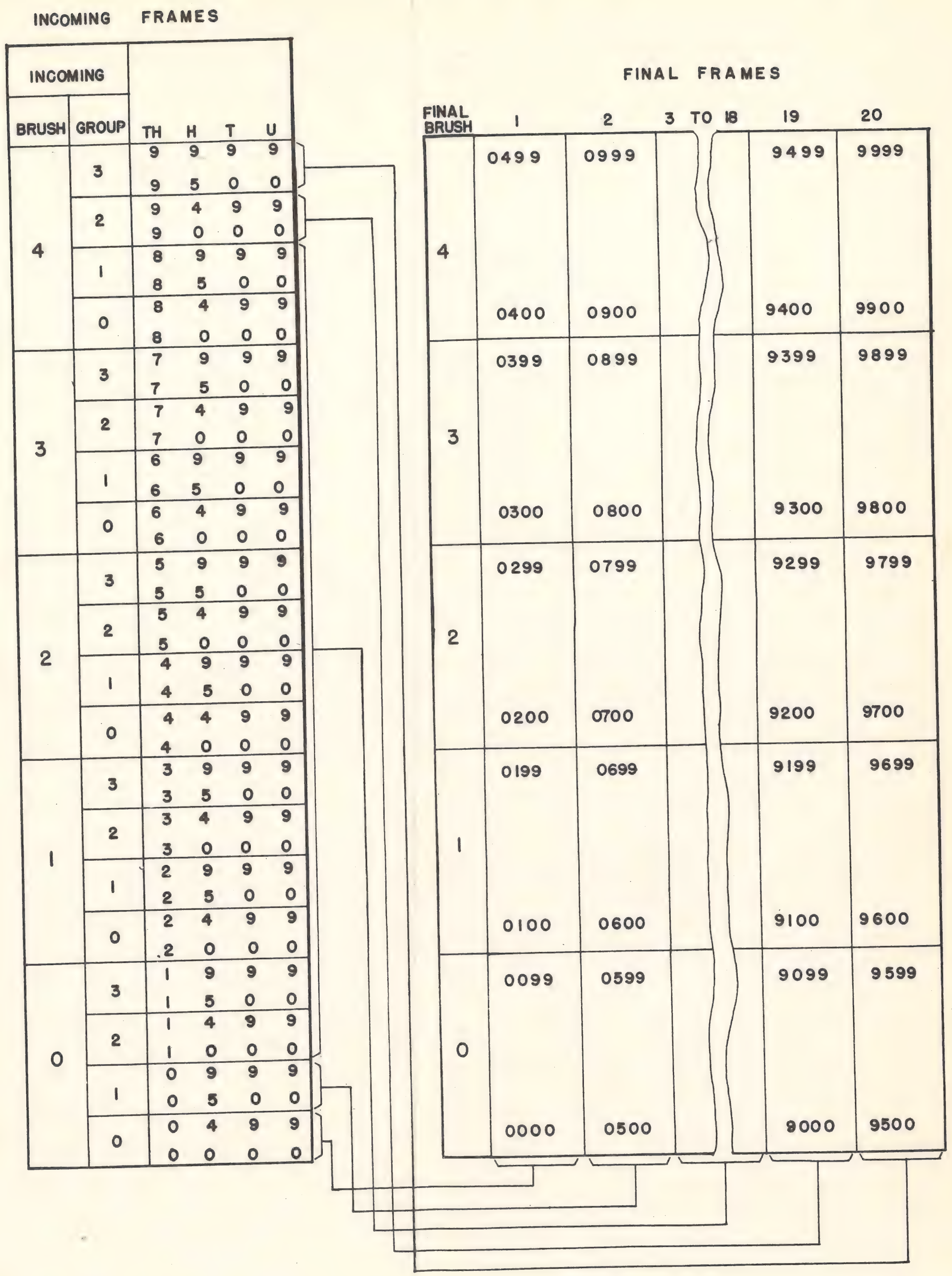
Certain P.B.X. circuits momentarily retard the current flow in the T and R leads at the end of dialing of each digit. The connection from the ring lead, through the DB condenser and resistance to ground, is provided to prevent a momentary release of the (L) relay and the consequent registration of a false pulse under this condition.


FIRST VERTICAL OF CROSSBAR REGISTER SWITCH
TO ORIGINATING MARKER CONNECTOR CIRCUIT
F10
F5
F4
F2
F1
HOLD MAGNET
O.N. GRD
(F)
SELECT MAGNETS
9
8
7
6
5
4
3
2
1
0
THROUGH REGISTER ADVANCE RELAYS
(F10)
O.N. GRD.
(F00)
O.N. GRD.
SELECT MAGNET AUX. RELAYS
(SM3)
(SM2)
P
S
(SM1)
(SC1)
(SC2)
F10
F00
F9
F8
F7
F6
F5
F4
F3
F2
F1
F0
SC
FROM SENDER LINK & CONTROL CIRCUIT
THRU MAKE CONTACT OF ONE OF CLASS OF SERVICE RELAYS

DISTRICT FRAME REGISTRATION
CROSSBAR SUBSCRIBERS SENDER

		OFFICE CODE	NUMERICAL CODE				
		A B C	TH	H	T	U	ST
CALLS TO CROSSBAR OFFICE		SENT TO ORIG. MARKER TO BE DECODED. MARKER ESTABLISHES A PATH TO A LOCAL OR DISTANT INCOMING TRUNK	THE NUMERICAL CODE IS TRANSMITTED TO THE TERMINATING CROSSBAR SENDER ON A REVERTIVE IMPULSE BASIS.				USED FOR PARTY LETTER OR FIFTH NUMERICAL IN MANUAL OFFICES WITH MORE THAN 9999 LINES
CALLS TO PANEL OFFICE		SENT TO ORIG. MARKER TO BE DECODED. INFORMATION RECEIVED BACK IS USED TO ESTABLISH CONNECTIONS THRU OFFICE BRUSH AND OFFICE GROUP SELECTIONS.	USED TO DIRECT INCOMING BRUSH	USED TO DIRECT FINAL BRUSH	USED TO DIRECT FINAL TENS	USED TO DIRECT FINAL UNITS	
			USED TO DIRECT INCOMING GROUP				
		REVERTIVE IMPULSE BASIS					
CALLS TO PANEL SENDER TANDEM		SENT TO ORIG. MARKER TO NOTIFY IT TO ESTABLISH A PATH TO SENDER TANDEM OFFICE.					
		THE OFFICE CODE AS WELL AS THE NUMERICAL CODE IS SENT TO THE PANEL TANDEM SENDER AS PCI PULSES					
TO MANUAL OFFICES	DIRECT	SENT ONLY TO ORIG. MARKER	SENT AS PCI PULSES				
	THRU MANUAL TANDEM	SENT AS PCI PULSES					
	THRU PANEL OFFICE TANDEM	USED TO ESTABLISH CONNECTIONS THRU OFFICE BRUSH AND GROUP SELECTIONS ON A REVERTIVE PULSE BASIS					

DIAL PROGRESS CHART



INCOMING FRAMES

INCOMING BRUSH	INCOMING GROUP	TH H T U
4	3	9 9 9 9 9 5 0 0
	2	9 4 9 9 9 0 0 0
	1	8 9 9 9 8 5 0 0
	0	8 4 9 9 8 0 0 0
3	3	7 9 9 9 7 5 0 0
	2	7 4 9 9 7 0 0 0
	1	6 9 9 9 6 5 0 0
	0	6 4 9 9 6 0 0 0
2	3	5 9 9 9 5 5 0 0
	2	5 4 9 9 5 0 0 0
	1	4 9 9 9 4 5 0 0
	0	4 4 9 9 4 0 0 0
1	3	3 9 9 9 3 5 0 0
	2	3 4 9 9 3 0 0 0
	1	2 9 9 9 2 5 0 0
	0	2 4 9 9 2 0 0 0
0	3	1 9 9 9 1 5 0 0
	2	1 4 9 9 1 0 0 0
	1	0 9 9 9 0 5 0 0
	0	0 4 9 9 0 0 0 0

FINAL FRAMES

FINAL BRUSH	1	2	3 TO 18	19	20
4	0499 0400	0999 0900		9499 9400	9999 9900
3	0399 0300	0899 0800		9399 9300	9899 9800
2	0299 0200	0799 0700		9299 9200	9799 9700
1	0199 0100	0699 0600		9199 9100	9699 9600
0	0099 0000	0599 0500		9099 9000	9599 9500

PANEL SYSTEM INCOMING & FINAL SELECTOR FRAMES

CHAPTER 3

SECTION 2

METHOD OF OPERATION

Subscriber Sender SD-25012-01

MARCH 1954

METHOD OF OPERATION

GENERAL

This section is devoted to a discussion of principal parts of the sender and a detailed circuit description of its operation.

PRINCIPAL PARTS OF SENDER AND OPTIONAL FEATURES

General Control Circuit This controls the connections between the sender and the sender link and control circuits, and the connections between the sender and the marker. It also registers the calling party of a two-party message rate line. In consists of the following relays:

Sender Control	(SC1), (SC2)	Off Normal	(ON1), (ON2), (ON3), (ON4)
Make Busy	(MB)	District Control	(DC)
Advance	(AV1) to (AV4)	Check	(CK)
Marker Start	(DST)	Marker Release	(DRL)
Trouble Release	(TR1) to (TR4)	Two Party	(TP), (TP1), (TP2)
Two-Party Timing	(TPT)		

Dial Pulse and Switchhook Control This receives and counts the dial pulses of each digit, and maintains switchhook supervision. It consists of the following relays:

Line Relay	(L), (L1), to (L5)	Slow Release	(SR), (SR1)
Pulse	(P1) to (P6)	Line Release	(LR)

Dial Register This registers on a crossbar switch all of the digits dialed and the district frame involved. The crossbar switch has ten verticals designated "F" for frame indication, "A", "AA", for the first digit, and "B", "C", "TH", "H", "T", "U", and "ST" for the other digits. Relays which register the class of service of the calling line may be included in this part of the sender. The relays involved are as follows:

District Frame	(F00), (F10)	Class of Service	(CS0) to (CS7)
Select Magnet	(SM1) to (SM3)	Register Advance	(RA), (RA1) to (RA5)
Dial Lock	(CL), (HL), (STL)		
PCI Progress	(A-A'), (B-B'), (C-C'), (STA-STA'), (TH-TH'), (H-H'), (T-T'), (U-U'), (STB-STB')		
Two Digit	(TD)		

Selection Register This is set up by the marker to record the class of call and compensating resistance required, and also the distant office selection (if any), station delay, and unit indication. The relays involved are as follows:

Class of Call	(CL1) to (CL4)
Compensating Resis.	(CR1) to (CR7)
Off. Brush	(OB1), (OB2), (CB4)
Office Group	(OG1), (OG2), (OG4), (OG5)
Skip Office	(SO)
Sec. Off. Br.	(SB1), (SB2), (SB4)
Sec. Off. Grp.	(SG1), (SG2), (SG4), (SG5)
Skip Second Off.	(SSO)
Station Delay and Unit Indication	(SD), (SD1)
Two Wire Office	(TW)

Fundamental Circuit This circuit recognizes direct or reversed battery and revertive ground pulses from the terminating sender or incoming and final selectors. The relays for these purposes, together with supplementary relays, are as follows:

Stepper	(STP)
Overflow	(OF), (OF1), (OF2)
Trunk Guard and Marginal Trunk Guard	(TG), (TG1), (TG2), (MTG)

Counting Relays These relays are operated and locked up in successive pairs by the pulsing of relay (STP), which is energized by the revertive pulses generated by the distant panel selectors or crossbar terminating sender. The relays consist of:

Counting Relays	(O), (BO), (FO), (1-1'), (2-2'), (3-3'), (4-4'), (5-5'), (6-6')

Release counter (RC) which assists in the use of the counting relay for a second time on a selection requiring more than six pulses.

Selection Sequence Circuit This circuit makes the proper internal connections in the sender in a definite order as the sender progresses through its successive selections and trunk tests in building up a connection to the called office and in a full selector call, to the called station. The relays involved are as follows:

Selection	(S1-S1') to (S~~7~~6-S~~7~~6')
Full Selector	(FS1), (FS2), (FS3)
Incoming Advance	(IA)

(FO1), (FO2), (FO3) which are generally supplementary to the counting relay (FO).

"PCI", Timing, Coin Test and Monitoring Circuits The "PCI" circuits generates alternative positive and negative "PCI" pulses, and makes the necessary internal connections for transmitting them. It consists of the following relays:

Call Indicator	(CI1), (CI2)
Pulse Generating	(PG), (PG1) to (PG3)
Start Pulse	(SP)
Grounding	(GR)
Final Pulse	(FP)
Pulse Ring	(PR)
Pulse Tip	(PT)

Supplementary Contact of Dial Register (12),(34).

The timing circuit measures off maximum allowed times for the calling subscriber to start dialing, for him to finish dialing, except for a stations digit, and for the sender to release after that.

If these times are exceeded, the timing circuit takes proper action to dispose of the call. If a timed release feature is provided, whereby the calling susbcriber is notified by tone to disconnect and if he fails to do so, the sender automatically releases. If a sender monitor is provided to request the subscriber to disconnect, and if he fails to do so, the sender is manually released. The following relays are employed:

Auxiliary to the Dial Register	(AL1), (AL2), (UL1), (UL2)
Permanent Signal	(PS)
Timing	(TM1) to (TM4)
~~Monitor's Lamp~~	~~(ML)~~
Stuck Sender	(SS)
~~Monitor's Sleeve~~ (For coin only)	~~(MS), (MS1)~~
~~Monitor's Tip~~	~~(MT)~~

RECEIVING AND RECORDING DIAL PULSES OS 201-1

The polarized relay (L) operated when the tip and ring leads were cut through from the calling line to its primary winding, and remains operated except for a momentary release on each break of the dial until the sender is disconnected, unless the subscriber hangs up to abandon the call. Relays (L1) and (L2) operate and release with (L). Relays (SR) and (SR1) operate on the first operation of relay (L) and release when the call is completed or abandoned. The (SR) relay being a slow release type holds up while the (L) relay releases during dial pulses, and in turn holds relay (SR1).

CHARACTERISTICS OF DIAL REGISTRATION RELAYS (L), (L1), (L2), (SR), (SR1), (RA) AND (RA1)

CHARACTERISTICS OF (L) RELAY

The primary winding of the (L) relay is its operating winding, and is connected in series with the line at this time. The tertiary winding, to which ground is connected by operation of the (ON1) relay, provides an electrical bias for the relay. This electrical bias compensates for variations in the voltage of the central office battery, as any increase or decrease in the magnetic field set up by the operating (primary) winding due to a change in voltage is counter-balanced by a corresopnding increase or decrease in the opposing (tertiary) winding. With this arrangement, there is always approximately the same relation between these two windings, and the operating and releasing properties of the relay are consequently not materially affected by fluctuations in voltage.

The electrical bias also causes the relay to be "power driven down" on a small reduction in its operating current. For example, if the operating winding provides 100 ampere turns and the biasing winding 90, a drop of only 15 per cent in the line current leaves the current in the bias circuit stronger by 5 ampere turns, forcing the relay to release.

The secondary winding of the (L) relay, in a circuit with the "PH" condenser, insures a minimum front contact closure of .012 second and a minimum back contact closure of .009 second, regardless of the percentage make and break of the dial contacts. These two extremes, of course, do not occur in the same dial pulse.

The minimum front contact closure is provided by the charging current of the "PH" condenser, after the relay operates, from battery through the secondary winding of the (L) relay, to ground through the winding of the (I1) relay and operated contacts of the (L) relay. This charging current is in the operate direction of the (L) relay and tends to hold it operated until the condenser becomes fully charged, even if the path through the primary winding should be opened before that time.

The minimum back contact closure is provided by the discharge of the "PH" condenser, this action starting as the relay breaks its front contact in releasing. The discharge current is in the release direction of the (L) relay. It assists the biasing winding in making the relay fast release and tends to hold its back contact closed until the condenser is fully discharged, even if the operating winding should be energized again before that time.

CHARACTERISTICS OF (L1) AND (L2) RELAYS

These relays operate and release with the (L) relay, serving to provide additional contacts.

CHARACTERISTICS OF (SR) AND(SR1) RELAYS

These relays operate on the first operation of the (L) relay and release when the call is completed or abandoned, both of which definitely release the (L) relay. They hold up continuously between those times, regardless of the momentary releases of the (L) relay due to dial breaks.

CHARACTERISTICS OF (RA) RELAY

The (RA) relay operates through a back contact of the (L1) relay on the first break of each digit dialed, and remains operated throughout that series of pulses despite the repeated momentary breaking of its operating path. It releases at the end of each digit dialed.

The (RA) relay has its secondary winding strapped, and it is held to an exact number of turns and its resistance to plus or minus ~~1~~ 3%, which holds it to the required slow release time with less variation than could be had by using a copper sleeve.

CHARACTERISTICS OF (RA1) RELAY

This relay operates when (RA) relay releases and releases when (RA) relay operates. In other words, while a series of pulses for one digit is being sent, the (RA1) relay is released. When the dial comes to rest after a series of pulses have been transmitted, the (RA1) relay operates.

Note: The ~~(RA1)~~ (RA) relay has its secondary wdg. strapped. This wdg. is held to an exact number of turns and its resistance to within plus or minus 3 per cent, to hold it to the required slow release time. There is less variation using this means than could be had by using a copper sleeve.

Relay (RA) operates through a back contact of relay (L1) on the first dial break of each digit dialed and remains operated throughout that series of pulses despite the repeated momentary breaking of its operating path. It releases each time the dial comes to rest after sending pulses for one digit. The (RA1) relay operates and releases in reverse to the (RA) relay, except that it can not operate for the first time until the (F) hold magnet operates. Relays (L3), (L4) and (L5), serve to transmit the dial pulses, alternately, to the pulse counting relays, (P1) to (P6).

When the (L) releases on the first break of the dial, it operates (L3). (L3) locks through the normal contacts of (L2) or the operated (RA), to grd. at (SR1). The reason for the parallel locking path is that the (RA) relay, because it is slow release, is of necessity slightly slow operate. The (L2) is fast release and provides a locking path for (L3) in case (RA) has not fully operated by the time (L) operates. The operation of (L) opens the operating path of (L3) and also operates (L1). (L1) operates (L2), but by this time the (RA) is operated so that the locking path of (L3) is unbroken. The operation of (L) removes the shunt from the (L5) allowing it to operate in series with (L3).

The operation of (L5) operates (P1) through the normal contacts of higher numbered (P) relays. The (P1) locks thru the (P) relay chain under control of (RA1). The release of the (L) on the second pulse operates (L4) in series with (L5). This releases (L3) and leaves (L5) locked in series with (L4) to the normal (L). (L4) locks momentarily to the (L3). This insures the release of (L3) before (L4) releases. (L1) and (L2) release with the (L). (L2) has no function after (RA) operates but the (L1) holds (RA) operated by a series of grd. pulses from its back contact. The (L) operates, on the next closure of the dial contacts, and releases (L4) and (L5). This operates (P2) which locks and releases (P1).

PRELIMINARY PULSE

An arrangement is used to prevent registration of the digit "1" due to switchhook interference before dialing, or due to its being dialed in error. It is not used as the first digit of codes dialed by subscribers in our area.

Any number of such preliminary pulses will be absorbed in the same way, provided that they are far enough apart so that the (RA) relay releases between them. The A digit, when it is received, is recorded on the A & AA verticals whether or not any preliminary pulses were received.

The number "1" can not be recorded on the A vertical as there is no path from the (P1) relay to the #1 select magnet until after the (AL1) relay has operated. If the (P1) is locked and the (P6) normal, the (P1) is released when the (RA1) relay operates at the end of the first digit, to prevent interference with succeeding digits. With no select magnet operated, the circuit does not cut-off dial tone and is prevented from advancing to the B register. There is no interference, however, with the registration of a "7", as the (P6) relay operated, provides a locking path for the (P1) relay, in turn permitting the #7 select magnet to operate.

After the A digit is recorded, the digit "1" can be recorded on any succeeding register as the operated (AL1) relay closes the path from the #1 select magnet to the (P1) relay, and off-normal contacts at the A hold magnet operated provide another path to lock the (P1) relay.

The following table shows the position of the dial pulse relays for any number of pulses from 1 to 10.

Pulse	L, L1, L2	L3	L4	L5	(P) Rel. Operated
1	R	O	-	-	
	O	H	-	O	(P1)
2	R	R	O	H	
	O	-	R	R	(P2) Releases (P1)
3	R	O	-	-	
	O	H	-	O	(P3) " (P2)
4	R	R	O	H	
	O	-	R	R	(P4) " (P3)
5	R	O	-	-	
	O	H	-	O	(P5) " (P4)
6	R	R	O	H	
	O	-	R	R	(P5 - P6)
7	R	O	-	-	
	O	H	-	O	(P1 - P6) Releases (P5)
8	R	R	O	H	
	O	-	R	R	(P2 - P6) " (P1)
9	R	O	-	-	
	O	H	-	O	(P3 - P6) " (P2)
10 (zero)	R	R	O	H	
	O	-	R	R	(P4 - P6) " (P3)

At the end of each even numbered pulse the cycle of the (L3), (L4) and (L5) relays is completed, and the beginning of each odd numbered pulse starts the cycle again.

When the last pulse of the A digit is recorded on the (P) relays, the (L) remains operated and holds (L1) causing the release of (RA). The release of (RA) operates (RA1) and one of the select magnets 0 to 9 (except number one). The select magnet to operate will be in accordance with the number dialed as indicated by the operated (P) relay or relays.

Note: The number one select magnet can not operate at this time as explained under "Preliminary Pulse."

The operated select magnet extends its operating ground, thru its off-normal contacts, to operate (SM1). The (SM1) locks itself and the select magnet before opening the locking path of the (P) relay and the operating path of the select magnet.

With the (P1) to (P6) relays normal, the pulses, for the B digit may now be registered on the (P) relays, but the operated (SM1) prevents the operation of a select magnet until crosspoints are closed for the "A" digit.

Registration of remaining digits is the same as for the "A" digit. If the subscriber dials "zero" operator the 0 select magnet will operate from the operated (P4) and (P6) relays and crosspoints will be closed on the A & AA vertical units with no further dialing necessary. 3 digit operator class codes, such as L.D. (211), are recorded on the A, AA, B and C vertical units, the same as any office code except that no number is required. For calls which require an office code and a 4 digit number, the office code is registered on the A, AA, B and C vertical units and the numberical digits on the TH, H, T and U verticals. On five digit numbers the units digit is recorded on the ST vertical. Station letters, J, M, R and W are not used in this area but when used, they are recorded on the ST vertical as numerals 5, 6, 7 and 9.

DIALING OFFICE CODE

Two-Digit Office Code If a two-digit office code is used, it is registered on "A" and "C" registers. The (TD) relay is omitted and optional wiring is furnished.

Two- and Three-Digit Office Codes If two- and three-digit office codes are used, (TD) relay is furnished, and it operates whenever the first digit dialed is one representing a block of two digit codes. In this case, the second digit causes the operation of the "C" hold magnet, while the third digit causes operation of the TH (HLD) magnets, etc.

In case a three-digit code is dialed (TD) is not operated and the second digit causes the operation of the "B" hold magnet.

Three-Digit Office Code If a three-digit office code is used, it is registered on "A", "B", and "C" register. The (TD) relay is omitted, and optional wiring is furnished.

At the present time, both two- and three-digit codes or 2-4 and 2-5 numbering plans are used, for this reason, the (TD) relay is furnished in the sender.

The "TD1" punching associated with the (TD) relay of Fig. 1 of the circuit drawing will be cross-connected to all "TD" punchings of Fig. 2 except "TD8". This causes the operation of relay (TD) whenever a first digit is dialed except 8 which indicates to the sender that the code to be dialed will be two-digit. If 8 is dialed for the first digit, then the (TD) relay remains normal as an indication to the sender that the code will be three-digit.

OPERATION OF HOLD MAGNETS FOR DIALED DIGITS OS 201-1, OS 202-1

When a select magnet operates from the (P) relay or relays, for the first digit, it operates (SM1). (SM1) locks and also locks the select magnet before opening the operating path of both (SM1) and the select magnet. (This is also covered on OS 201-1. With (SM1) operated (SM2) operates and closes an additional grd. to lock the select magnet and hold (SM1). The reason for locking the select magnet to (SM2) is so that it can not release until after the hold magnet operates. (SM2) also operates (SM3) and this in turn releases (SM1).

Note: The path for operating the A & AA hold magnets was prepared in part by the operation of relays (RA2), (RA3) and (RA4) during frame registration.

The operated (SM3) closes a grd. from (ON1) thru the 75^w resistance and secondary winding of (SM2) to operate the A hold magnet. The AA hold magnet operates from the same ground thru the operated (SM3) and then locks to the F hold. (RA2) is shunted and (RA3) is held operated by (SM3).

The reason for operating and locking the A hold, under control of the (PS) relay, will be covered on OS 203-1 and OS 217-1.

The release of (SM1) opens the operating path of (SM2) but (SM2) holds thru its sec. wdg. in series with the A hold magnet. When the A hold operates it locks and shunts (SM2). The release of (SM2) releases the select magnet and (SM3).

The release of (SM3) opens the operating path of the A hold and releases (RA3). The release of (RA3) removes the shunt from (RA5) allowing it to operate thru the operated (RA4). The register advance relays, are now set up ready to record the B digit.

Each time a digit is dialed the setting of the (P) relays, at the time (RA) releases, causes one of the select magnets to operate. (SM1), (SM2) and (SM3) operate the same as described for the A digit. (SM3) operates the hold magnet, releases (SM1), and sets the register advance relays in position for the next digit.

The path for operating any hold magnet, except AA, is the same up to the bottom contact of (RA3). From this point on the path is steered thru the transfer contacts of (RA3), (RA5), (CL) and (HL) to the proper hold magnet.

In general a contact of each hold magnet provides a locking grd. for the next one.

The (CL) relay, which operates from a contact of the C hold magnet, opens the operating paths of the F, A and B hold magnets, and closes the paths for operating the TH, H and T hold magnets. The (HL) relay which operates from a contact of the H hold, opens the operating paths of the C and TH hold magnets and closes the paths for operating the U and ST hold magnets. Another function of the (CL) relay is to start circuit action to call in an OM. This will be covered on OS 203-1.

CONNECTING THE SENDER THRU THE ORIGINATING MARKER CONNECTOR TO AN ORIGINATING MARKER OS 203-1

The functions of the OM are divided into two stages, known as the "Decoding" stage and the "Marking" stage. When the OM is in the "Decoding" stage it is receiving information from the sender, decoding the office code in order to operate a route relay, and transmitting information to the sender. When the OM is in the "Marking" stage it is performing the following functions; selecting a trunk on the OL and building a channel thru the DL and OL which will connect the DJ to the selected trunk. The OMC, which connects the sender to the decoding portion of the OM, is only required while the OM is in the decoding stage. The connector is therefore released when the OM has selected a trunk, which is the first step in the marking stage. The reason for waiting until a trunk is selected before releasing the connector is so the selection register relays in the sender may be released and set up in a difference combination, in case the marker finds all trunks busy in the original route and selects a trunk in the alternate route or in the overflow group.

The sender requires an OM to establish a connection to a trunk on the OL, on all classes of calls. If the subscriber fails to dial at all or if the sender monitor primes (releases) the sender while the subscriber is still connected, due to some trouble condition, an OM is called in to route the subscriber's line to a permanent signal trunk. When the sender is ready to be connected to an OM, the following circuit action takes place.

FIRST TRIAL WITH THE MARKER

The (DST) relay operates upon the operation of the (CL) relay, indicating the office code has been dialed; or when the 0 crosspoint on the AA vertical closes, showing that zero has been dialed for the first digit; or when (PS) relay operates to indicate dialing has not commenced in the allowed time or that the sender has been primed.

The operation of (DST) connects battery to the "ST" and "CBS" leads to the OMC, with the effect that the sender is connected to an OM as soon as the connector and a marker are available.

The sender then transmits the office code, class of service and DL frame number to the OM and receives from the marker the information which it will require later to complete the connection in the called office. Detailed circuit action on the above phases, of the call, will be covered later.

When the OM has completed its decoding functions, but before the OMC releases, the "DC" lead is grounded by the OM. This ground operates the (DC) relay in the sender, the (F) relay in the DJ, and is extended by the (F) relay to operate the (LC) relay in the DLC. The operation of the (DC) relay notifies the sender that the marker is connected to the DL frame. The marker must locate the DJ on the district frame before it can build a channel between the DJ and the trunk, and it does this by operating the (F) and (LC) relays via the sender and SSL. Ground on the "AK" lead from the marker holds the (LC) in the DLC, (F) in the DJ, and (DC) in the OS so they will not release when the OMC releases.

RELEASE OF ORIGINATING MARKER CONNECTOR

When the OM reaches the marking stage and has no further use for the OMC it grounds the "RL" lead to operate the (DRL) relay in the sender. The (DRL) locks and opens the "ST" lead to the OMC thereby releasing the connector and breaking all direct connections between the sender and the OM. The OM is still indirectly connected to the sender thru the DL, DJ and SSL. When the OM has completed its marking functions it removes ground from the "AK" lead releasing relays (LC) in the DLC, (F) in the DJ and (DC) in the OS. The release of the (DC) notifies the sender that it is connected thru the DJ to the trunk.

TROUBLE RELEASE OF ORIGINATING MARKER

If the OM encounters trouble in receiving information from the sender, in decoding or in transmitting information to the sender, it sends a trouble release signal to the sender by grounding the "TRL" lead thru the OMC. This operates the sender (TR1) relay which releases the (DST) relay. Battery is removed from the "ST" and "CBS" leads by the release of DST, thereby causing the release of the connector. The (DRL) is not operated at this time. When the "TRL" lead is broken by the release of the connector, the (TR2) operates in series with the (TR1).

SECOND TRIAL WITH A MARKER

The (DST) relay now reoperates and again connects battery to the "ST" and "CBS" leads with the result that a second connection is set up thru the connector to a marker. This may be the same marker as before but usually will be a different one, since the first marker holds itself busy momentarily after sending a trouble release. With the (TR2) operated, the "AR" lead is grounded to the second marker notifying it to use the alternate route to the desired point if there is one. The second marker will now try to establish the connection.

TROUBLE RELEASE ON SECOND TRIAL

If the second marker encounters trouble while in the decoding stage, the "TRL" lead will again be grounded but this time the (TR3) will operate because (TR1) and (TR2) are already locked up. The operation of the (TR3) will release the (DST) and it in turn will remove battery from the "ST" and "CBS" leads causing the release of the connector and marker. The connector in releasing breaks the "TRL" lead and allows the (TR4) relay to operate in series with the (TR3) relay.

THIRD TRIAL WITH MARKER

Relay (DST) now reoperates and places battery on the "ST" lead setting up a third connection to the connector and marker. (TR3) relay operated will ground the "OF" lead to the third marker notifying it to use the overflow route. The third marker will now attempt to establish a connection to the overflow tone trunks.

TROUBLE RELEASE ON THIRD TRIAL

If the third marker encounters a trouble condition while in the decoding stage, the "TRL" lead will again be grounded. This time the (TR3) relay will be shunted down while the (TR4), (TR2) and (TR1) relays remain locked. When the (STL) operates, indicating that dialing is completed, relay (AV1) operates. With relay (AV1) operated, the district is placed in talking position and the sender restores in the usual way, even though no connection is made to an outgoing trunk. The district will hold until the calling subscriber disconnects.

ALL TRUNKS BUSY

On first or second trials if all trunks to the called point and all overflow trunks are busy, the marker grounds lead "RO", operating and locking the (TR4) relay. The (TR4) relay in turn operates the (DRL) relay and this dismisses the connector and marker by opening the "ST" lead. When (STL) operates indicating dialing has been completed, relay (AV1) operates causing the sender to restore to normal.

On third trial if all trunks are busy the marker grounds the "TRL" lead which shunts down the (TR3) relay while the (TR4), (TR2) and (TR1) relays remain locked. When dialing has been completed the (STL) relay will operate and close ground to operate the (AV1) relay which will release the sender.

If the marker functions successfully and is dismissed, but the sender in making selections, receives an overflow signal because of the distant panel selector running to overflow or telltale, or because of some trouble effecting the crossbar terminating sender, the (AV2) relay will close off-normal ground to the "TRL" lead. This causes the (TR-) relays to function as described under "Trouble Release".

TROUBLE RELEASE THRU DISTRICT LINK CONNECTOR

If the OM encounters trouble or an all channel busy condition during first or second trial, after the OMC has been released, the marker grounds the "TRL" lead thru the DLC and sets up the trouble release relays in the same manner as described under first or second trial. This time, however, the (DRL) relay which was previously operated will release when the (DST) releases. The selection register relays in the in the OS, which were set up by the OM, will release when the (DRL) relay releases OS 205-1. The release of the (DRL) also releases the (TC) or (OT) relay in the M.R. DJ or the (AO) in a coin DJ by opening the "LR" lead OS 211. These relays are set up by the OM to indicate whether "Operator Transmission" (OT) or "Talk Charge" (TC) should be used. The reason for releasing the selection relays in the sender and the "charge" relays in the DJ between trials, is so that they can be set up in a different pattern if necessary on the next trial.

TRANSMITTING INFORMATION TO ORIGINATING MARKER OS 204-1

The sender transmits information to the OM by grounding certain leads within a group of 24 leads cut thru by the OMC. Each lead is connected to the winding of a register relay in the OM that bears the same designation as the lead to which it is connected. The register leads grounded by the sender for a particular call, are referred to as "used" leads, and the leads that are not grounded are referred to as "unused" leads. In addition to the 24 register leads there are 4 check leads designated "CK1" to "CK4" used for checking the "unused" leads for opens and false grounds and thereby preventing false registration in the OM.

In the following example, all of the 24 register leads are either grounded by the sender or connected to check leads. Assume that office code 764 was dialed, that the call is from district frame 9 and that class of service relays (CS4) and (CS6) operated.

	CROSSBAR REG. SW.			RELAYS						
	A	B	C	F	FOO	CS4	CS6	TP1	TR2	TR3
Leads Grounded	A2,A5	B1,B5	C4	F4,F5	None	D1,D4	None		None	
Leads Checked	A1,A4	B2,B4	C1,C2,C5	F1,F2	F10	D2	D8	TP	AR	OF

In the above example the sender grounds 9 register leads, which operate corresponding register relays in the OM, and connects the remaining 15 register leads to the check leads. The OM then connects ground to the check leads causing the 15 "unused" register relays to operate. If all register relays operate it indicates that none of the leads are open. After the OM checks to determine that all register relays have operated, it removes ground from the 4 check leads thus releasing the unused register relays. If an unused lead is falsely grounded it will ground the check lead to which it is connected and prevent the release of all register relays connected to this check lead. The OM will recognize this as a false registration. Should any of the leads be open or falsely grounded the OM calls in the trouble indicator and sends a trouble release signal to the sender.

If no trouble is encountered by the OM in recording and checking the information from the sender, the OM proceeds to operate the route relay assigned to the code 764. This will be covered in detail in the OM course. (The (TP1) relay operates and grounds the "TP" lead to the OM if the tip party of a 2MR line is calling.)

If the subscriber fails to dial or if the sender is primed by the sender monitor the (PS) relay operates and grounds the "A1" and "A4" leads to the OM. The marker recognizes this as the permanent signal code and routes the call to a P.S. trunk.

The last sender in each group of 10 senders is equipped with an (LC) relay for load control. If the load control feature is used the (LC) relay operates and grounds the "A2" and "A4" leads to the OM. The marker recognizes this as the code for load control and routes the call to an overflow trunk.

RECEIVING INFORMATION FROM ORIGINATING MARKER OS 205-1

The sender requires certain information from the OM before it can proceed to complete the connection in the called office. The OM transmits this information to the sender by grounding a selection of leads which operate like designated relays in the sender. These relays, called selection register relays, lock up under control of the (DRL) and (DST) relays so that they may be released and set up in a different pattern for a second or third trial.

CLASS

The class of call is indicated by relays (CL1) to (CL4) and (TW).

None	Full selector to Panel
(CL1)	Full selector to Crossbar or XB Tan.
(CL1), (CL2), (CL4)	K.D.C.I. (Key display call indicator)
(CL1), (CL2), (CL4), (TW)	A.D.C.I. (Automatic display call indicator)
(CL2), (CL4), (TW)	F.S. Tandem (code and number transmitted by P.C.I. Pulses)
(CL4)	Restricted code, sender awaits number (Example: Emergency reroute and 7 and 8 digit ovfl.)

(CL2), (CL3), (CL4)	Official Code thru Tan. (Not used).
(CL3), (CL4)	Operator Class (Zero, 211, 411, etc.)
(CL3), (CL4), (TW)	Perm. Signal and Vac. Code (Operator class, with Rev. Batt. and Grd.)

(CL1) operates on XB calls. (Delays trunk test until H- register is dialed).
(CL1) operates on PCI direct. (Cancels A-B-C register on CI pulsing).

(CL2) operates on all PCI calls (Extends time out period).

(CL3) operated, cancels numericals (Operator class call).

(CL4) operates on all calls except Full Selector calls.

With the (TW) relay operated the following action takes place in the sender:

1. Time out period for a stuck sender is extended.
2. On abandoned A.D.C.I. calls, sender awaits display.
3. (OF) relay is shunted on opr. class trunks having reversed battery and ground.

COMPENSATING RESISTANCE

Used to build up the resistance of the fundamental circuit to a minimum value.

Since the relays in the fundamental circuit (namely: the (STP), (TG) and (MTG) of the subscriber sender, and certain other relays at the intermediate and "B" end of the trunk) are required to operate on specified current flow requirements, it is necessary to maintain the resistance of this circuit within certain limits. The operating limits of these relays are dependent on the external (Cable) resistance of the trunk circuit, which must be maintained at a minimum of 900 ohms.

The resistance of the cable conductors of different trunk groups vary over a wide range depending upon the length and gauge of these wires. Since the cable resistance is fixed for a particular group of trunks, and since the sender must work into any outgoing trunk group in the office, some means must be provided to compensate for the low resistance of those trunk groups of less than 900 ohms.

A compensating resistance, in increments of 300 ohms, is inserted into the fundamental circuit by means of the (CR-1 to CR-4) relays.

Compensating Resistance

Relays Operated	Office Test and Office Selections	Trunk Test and Inc. and Final Sel.
None	900	0
(CR1)	600	0
(CR2)	300	0
(CR1), (CR2)	0	0
(CR3)	900	300
(CR1), (CR3)	600	300
(CR2), (CR3)	300	300
(CR4)	900	600
(CR1), (CR4)	600	600
(CR3), (CR4)	900	900

The (CR5) relay, although it does not affect the comp. resistance, is also included in this group. It may be operated with any of the above combinations when the call is to a "ground cut off" type Panel office with non-repeating Incoming trunks.

The operated (CR5) relay substitutes the trunk guard relay (MTG) for the (TG) relay, closes a cable discharge circuit before final brush selection, and closes an auxiliary path for operating relays (O), (BO) and (FO). This will be explained in detail later.

Trunks to Panel offices, of the type just mentioned, return a 24V battery pulse while restoring to normal. If the trunk is seized before it has restored to normal from the previous call, the 24V battery pulse would give a false Trunk test indication to the sender. The marginal (MTG) relay will not operate on 24V and is used in place of the (TG) relay to prevent this false indication.

OFFICE BRUSH

Office Brush selection is indicated by the setting of relays (OB1) (OB2), (OB4) and (OB5). Also included in this group are the (SD) and (SD1) relays.

Relays Operated	Office Brush
None	0
(OB1)	1
(OB2)	2
(OB1), (OB2)	3
(OB4)	4
*(OB5)	5
(OB5), (OB1)	6
(OB5), (OB2)	7
(OB5), (OB1), (OB2)	8
(OB5), (OB4)	9

*SSO lead is used to operate (OB5) relay.

When Crossbar Tandem is arranged for more than 50 codes, the (CB5) relay is used to add 5 pulses to office brush selection. The first group of 50 codes will be reached by using OB selections 0 to 4 and the second group of 50 codes by OB selections 5 to 9.

The (SD and SD1) relays are used to give the following information to the sender:-

CALLS TO ALL OFFICES

1. (SD) normal indicates that the called office has station letters. In this area station letters are not used and, therefore, (SD) is always operated except on certain operator class calls.

CALLS TO MANUAL OFFICES

2. (SD1) normal indicates that the called office has 5 digit numbers.

3. (SD1) operated indicates that there are no 5 digit numbers in the office.

CALLS TO CROSSBAR OFFICES

4. (SD1) normal causes the OS to give a "B" office indication to the Crossbar terminating sender.

5. (SD1) operated will cause the OS to give an "A" office indication to the Crossbar terminating sender.

CALLS TO PANEL OFFICES

6. (SD1) is always operated on calls to Panel Offices.

OPERATOR CLASS CALLS

7. (SD) normal and (CL3) operated cancels coin test in the sender. When coin test required on certain Operator class calls, then (SD) will be operated.

On calls to offices having station letters or 5 digit numbers the normal (SD) or (SD1) relay will cause the sender to wait a few seconds after units is dialed in order to record the station letter or 5th digit, if one is expected.

OFFICE GROUP

Office Group selection is indicated by the setting of relays (OG1) (OG2), (OG4) and (OG5). The (SO) relay is also included in this group.

Relays Operated	Office Group Selection
None	0
(OG1)	1
(OG2)	2
(OG1), (OG2)	3
(OG4)	4
(OG5)	5
(OG5), (OG1)	6
(OG5), (OG2)	7
(OG5), (OG1), (OG2)	8
(OG5), (OG4)	9
(SO)	Skip Office Selections

If the call is routed over a direct trunk to the called office or thru F.S. Tandem, skip office relay (SO) is operated. If the call is routed thru Crossbar Tandem or a "Two Wire Office" frame then office selections are required and (SO) relay will not be operated by the Marker.

OFFICIAL

The (SG5) relay is operated by the Marker, on first trial, when the code "OFF" is received but is not operated on second trial. This feature is covered in detail on OS 210-1.

INDICATING THAT DIALING IS COMPLETED OS 206-1

The subscriber sender must have an indication that dialing is completed in order to proceed with its functions for all classes of calls. The operation of (STL) relay indicates that dialing is completed, and the operation of the (UL1) relay indicates that the units digit has been recorded.

OPERATOR CLASS (NO NUMBER EXPECTED)

On permanent signal, zero operator and 3 digit operator class calls, the marker operates (CL3) to show that no number is expected. Off-normal ground through (DRL), normal (CL1), operated (CL3), operates relays (STB) and (STB'). Operated (STB') operates (STL).

PANEL CALL: Relays operated are, (SD), (SD1) and (UL1). Relays normal are, (CL1, 2, 3 and 4).

Off-normal ground through operated (DRL), normal (CL1), T9 and 8 (UL1), TH and H crosspoints, through normal (CL2) or around (CL2), operated (SD), operates (STB) and (STB') relays. Operated (STB') operates (STL).

CROSSBAR CALL: Relays operated are, (CL1), (C), (C'), (SD) and (UL1). (SD1) may be operated or normal.

Off-normal ground through operated (DRL) is now steered through operated (C) to operate (STB) and (STB') relays. Operated (STB') operates (STL).

P.C.I. CALL

Sender delay relay (SD) is operated by the marker to show that the terminating office has no party lines with station letters. Station letters are not used in Chicago.

On P.C.I. calls, sender delay relay (SD-1) is operated by the marker to show that there are no five digit numbers in the called office. Conversely (SD-1) normal shows that the called office has numbers over 10,000 and a delay is required for dialing a fifth digit.

On all calls except Panel and Tandem, relays (C) and (C') operate when (CL1) and (DRL) operate.

P.C.I. CALL No numbers over 9999

Relays operated are, (CL1, 2 and 4), (C), (C'), (SD), (SD1) and (UL1).

(A) Number begins with digits one-zero

Off-normal ground through operated (DRL) operated (C) T 9 and 8 (UL1), #1 crosspoint TH vertical, #0 crosspoint H vertical, operated (CL2), (SD1) and (SD) relays, operates (STB) and (STB'). Operated (STB') operates (STL).

(B) Number does not begin with digits one-zero

Off-normal ground through operated (DRL), operated (C), T 9 and 8 (UL1), through crosspoints TH vertical, operated (SD), operates (STB) and (STB') relays (STB') operates (STL).

P.C.I. CALL Numbers over 9999 and called number is over 9999

Relays operated are, (CL1, 2 and 4), (C), (C'), (SD) and (UL1). (SD1) normal.

When subscriber dialed the fifth digit, the ST HOLD magnet operated. Off-normal ground through operated (DRL), operated (C), T 9 and 8 (UL1), #1 Crosspoint TH vertical, #0 Crosspoint H vertical, operated (CL2), now normal (SD1), ST hold magnet, operates (STA') and (STA) relays. Relay (STA) operates (STL).

TIMING FOR FIFTH DIGIT

When a subscriber is slow in dialing the fifth digit, or if only a four digit number beginning with one-zero is to be dialed, the sender awaits the time necessary for dialing a fifth digit. The (SD) interrupter .530 second made and .530 second break measures off the delay period in the following manner. Off-normal ground through operated (DRL), operated (C), B8 and 7 of (UL1), normal (STL), grounds (SD) interrupter to count its cycles on relays (H), (H'), (T), (T'), (U), (U'), (STB) and (STB') each cycle causing one pair of relays to operate and lock. (STB') relay operates (STL) relay.

If a subscriber abandons a call at the time the sender is awaiting the dialing of a fifth digit, the (STL) relay will be operated by the operation of the (LR) line release relay.

When the (STL) relay operates, regardless of the class of call, it permits the sender to advance.

SUMMARY OF OPERATIONS

The circuit actions in the sender follow the same general pattern, up to this point in the call, regardless of the number dialed. That is, the sender records the dialed digits, transmits information to the Marker as soon as the code is dialed and receives from the Marker the information which it requires before starting to complete the call.

The sender is advanced from one operation to another by certain relays which may be called key relays, such as the (L), (DST),(DRL), (DC) and (STL). When the (L) operates, indicating that the subscriber is connected to the sender, dial tone is sent to the subscriber and the LL and SSL controllers are released. When the office code or zero has been dialed the (DST) operates and starts a series of circuit actions which connects the sender to a Marker. The operation of (DRL) locks in the selection register relays set up by the Marker and releases the OMC. The operation and release of (DC), prepares the sender for trunk test, the release of (DC) indicating that the sender is connected to a trunk. When dialing is completed (STL) operates and permits the sender to make trunk test on Manual, F.S. Tandem and Operator class calls. On calls to Panel and Crossbar offices the sender is blocked in final units selection if (STL) has not operated by this time.

After receiving information from the Marker, the sender makes trunk test and then proceeds to transmit the number, as shown in simplified form on OS 208-1.

The sender is arranged to complete calls to 6 different types of offices. The method used by the sender in transmitting the number or the office code and number is shown below.

Type of Office	Office Code	Number
Manual		PCI Pulses
F.S. Tandem (Pan. Type)	PCI Pulses	PCI Pulses
Panel		Revertive Pulses
Crossbar		Revertive Pulses
Crossbar Tandem	OB & OG Sel. by R.P.	R.P. or PCI Pulses
Two Wire Office (Pan. Type)	OB & OG Sel. by R.P.	R.P. or PCI Pulses

FUNDAMENTAL CIRCUIT OS 207-1

This consists of relays which are cut into the Fundamental Tip and Ring for Office Test, Trunk Test, Full Selector Selections and for sending P.C.I. pulses to Tandem or Manual offices. The fundamental circuit is controlled by the Selection Sequence Circuit.

SELECTION SEQUENCE CIRCUIT OS 209-1

The Selection Sequence circuit makes the proper internal connections in the sender in a definite order as the sender progresses through its various selections and trunk tests in building up a connection to the called office, and on a Panel call, to the called number.

On any class of call routed through a Two Wire Office selector or Crossbar Tandem Office the selection sequence relays are operated as follows for Office Test and Office Selections up to and including Trunk Test.

(S3) and (S3') Office Test
(S4) and (S4') Office Brush Selection
(S5) and (S5') Office Group Selection
(S6) and (S6') Trunk Test

On a full selector call to either Panel or Crossbar the selection sequence relays and the (FS-) relays, are operated as follows for Trunk Test and the various Selections.

(S6) and (S6') Trunk Test	
(S1) and (S1') Incoming Brush Selection	(FS1) and (FS2)
(S2) and (S2') Incoming Group Selection	(FS1) and (FS2)
(S3) and (S3') Final Brush Selection	(FS1) and (FS2)
(S4) and (S4') Final Tens Selection	(FS1), (FS2) and (FS3)
(S5) and (S5') Final Units Selection	(FS1), (FS2) and (FS3)
(S6) and (S6') Incoming Advance	(FS1), (FS2) and (FS3)

On P.C.I. and Operator Class calls the (S6) and (S6') remain operated after Trunk Test.

OFFICE TEST AND OFFICE SELECTIONS

PREPARING FOR OFFICE TEST OS 209-1

When the (DST) relay operated it closed off-normal battery to the winding of (RC) and (FO3). This caused the operation of (RC) in turn operating (FO3) which locks under control of (FO2). When the OM operates (DRL) and (DC) relays a path is closed through normal (S0) to operate relay (S3). Another function of the (DC) relay is to soak the (STP) in the direction of its normal operation, and so remove the effect of any preceding reverse current OS 207-1.

The sender proceeds to make Office Test, which is followed by Office Brush and Group Selections, as soon as the (DC) relay releases. This may take place before dialing is completed. If the sender advances as far as Trunk Test, before dialing is completed, then the sender is blocked. This will be covered under Trunk Test.

FUNDAMENTAL CIRCUIT FOR OFFICE TEST OS 207-1

During Office Test, the Fundamental is closed from the "FT" lead through the normal contacts of (AV2), operated (FO3), normal (FO2), operated (S3) normal (FS1), winding of (MTG) or (TG), operated or normal contacts (CR5), normal (CI2), 14,500 ohms resistance, operated (S3'), operated or normal (CR2) and operated or normal (CR1) to the "FR" lead. The (TG) or (MTG) will now operate from battery on the Tip and ground on the Ring of the distant office trunk circuit. The 14,500 ohms resistance in the fundamental prevents the "Line relay in the trunk cct. from operating at this time.

OFFICE TEST OS 209-1

The operation of (TG) operates (TG1) which in turn operates (TG2), or the operation of (MTG) operates (TG2) and this operates (TG1). Relay (TG2) operates (O), (BO) and (FO) through the normal (S6). (FO) operates (S4). A path is now closed through the operated (S4) and (S3') relays to operate (FO1) relay. (FO1) operates (FO2) and this releases (RC) and (FO3). The operation of (FO2) and the release of (FO3) opens the Fundamental causing the release of (TG) or (MTG) OS 207-1. Relays (TG1), (TG2), (O), (BO) and (FO) will also release in turn. The release of (FO) allows (S4') to operate in series with (S4). The operation of (S4') releases (S3) and (S3'). The release of (S3') release (FO1) and this releases (FO2). (RC) and (FO3) will now reoperate. The operation of relays (FO3) and (S4') and the release of (FO2) closes the fundamental for Office Brush Selection.

FUNDAMENTAL CIRCUIT FOR OFFICE BRUSH SELECTION OS 207-1

During Office Brush selection the fundamental is closed from the "FT" lead through the normal contacts of (AV2), operated (FO3), normal (FO2) operating winding of (OF) in parallel with its non-inductive windings, operated (S4') winding of (STP), normal contacts (BO) and (FS2), operated (S4') operated or normal (CR2) and operated or normal (CR1) to the "FR" lead.

OFFICE BRUSH SELECTION

Detailed circuit operation of the (STP) and counting relays for all selections will be covered on OS 210-1.

The (STP) and (OF) relays are now bridged across the "FT" and "FR" leads. Battery and ground from the distant office trunk circuit, which was used for operating the (TG) relay, will now operate the (STP) but not the (OF), because of its polarity. Without the 14,500 ohms resistance in the Fundamental, the "line" relay in the trunk cct. will operate in series with the (STP). This starts circuit action in the Crossbar Tandem office which results in connecting the trunk to a sender. In a Two Wire Office, the "line" relay advances the office selector circuit so it is in position to make Office Brush Selection.

When this has been done the Tandem sender or office selector starts revertive pulsing, which consists of ground pulses imposed on the fundamental tip. These pulses alternately shunt the (STP) relay and permit it to reoperate. The (STP) relay causes a pair of counting relays to operate and lock as each pulse is received. Each succeeding pulse is counted on the next lower numbered pair of counting relays. The point at which the count starts and the number of counting relays included in the selection is determined by the setting of the (OB) selection register relays. For example, if the (OB4) relay is operated then the first pulse operates the #4 counting relay.

The sender permits pulsing to continue until the last set of counting relays operate, which is always the (O), (BO) and (FO). The (BO) relay opens the Fundamental to prevent the reoperation of (STP), and to stop pulsing in the distant office. The pulses are used to control Office Brush Selection in the distant office.

PREPARING FOR OFFICE GROUP SELECTION OS 209-1

The operation and release of (STP) on the last pulse of office Brush selection, caused the operation of (O), (BO) and (FO) relays. The (BO) opens the fundamental as previously explained, and the (FO) operates (S5). (FO1) operates through the operated (S5) and (S4') relays. (FO1) operates (FO2) and this releases (RC) and (FO3). The release of (FO3) releases (O), (BO) and (FO).

The fundamental is closed in part by the release of (BO) but is still held open by the operated (FO2) and normal (FO3).

The release of (FO) allows the (S5') to operate in series with (S5). (S5') releases (S4) and (S4'). The release of (S4') releases (FO1) and this releases (FO2). The (RC) and (FO3) relays now reoperate.

FUNDAMENTAL CIRCUIT FOR OFFICE GROUP SELECTION OS 207-1

During office group selection the fundamental is closed from the "FT" lead through the normal contacts of (AV2), operated (FO3), normal (FO2), operating winding of (OF) in parallel with its non-inductive winding, operated (S5'), winding of (STP), normal (BO) and (FS2), operated (S5') operated or normal (CR2) and operated or normal (CR1) to the "FR" lead.

OFFICE GROUP SELECTION

When the fundamental is closed by the operation of (FO3), the (STP) and (OF) relays are again bridged across the "FT" and "FR" leads. This signals the distant office that the originating sender is ready for Office Group Selection. The (STP) responds to ground pulses from the distant office and operates a pair of counting relays as each pulse is received, the same as during office brush selection. The setting of the (OG) relays determines the number of counting relays to be included in the selection. When (O), (BO) and (FO) operate, it indicates that the required number of pulses have been received. The (BO) opens the fundamental and this stops the pulsing in the distant office.

PREPARING FOR TRUNK TEST OS 209-1

The operation of (FO) operates the (S6). With (S6) and (S5') operated, the (FO1) operates and causes (FO2) to operate. (FO2) releases (RC) and (FO3). The release of (FO3) releases the (O), (BO) and (FO) counting relays. (S6') operates in series with (S6) when (FO) releases. (S5) and (S5') are released when (S6'~~8~~) operates.

With relays (S6) and (S6') operated, the sender is in position to make Trunk Test as soon as the fundamental is closed.

When Office Selections are required then (S6) and (S6') relays operate as previously described, but when Office Selections are not required then (S6) operates through the operated (SO) when (DRL) and (DC) operate and (~~S68~~ S6') operates when (DC) releases.

The operated (S6) closes a path to hold (FO1) operated, if Office Selections were made, or it operates (FO1) for the first time if Office Selections are not required. (FO1) releases when dialing proceeds far enough to operate the TH Hold magnet on calls to Panel Offices or the H Hold magnet on calls to Crossbar offices or when dialing is completed, on calls to F.S. Tandem or Manual Offices, as indicated by the operated (STL).

The reason for this delay on Panel and Crossbar calls is to prevent the sender from making Trunk Test and then starting Incoming Brush Selection before the Thousands digits is dialed. The Incoming Brush required is determined by the Thousands digit dialed and as there is no delay for dialing between Trunk Test and Incoming Brush, the delay must occur before Trunk Test is made. On Crossbar calls only, Trunk Test is delayed until Thousands and Hundreds is dialed to reduce the holding time of the Terminating Sender. On calls to F.S. Tandem or Manual Office, Trunk Test is delayed until dialing is completed, to prevent holding common equipment in the called office, while the subscriber is dialing. On operator class calls, Trunk Test is made when (STL) operates, indicating that dialing is completed.

When dialing has progressed far enough to release (FO1) then (FO2) releases and operates (RC) which operates (FO3). This closes the fundamental for Trunk Test.

FUNDAMENTAL CCT. FOR TRUNK TEST OS 207-1

FULL SELECTOR CALL

During Trunk Test the fundamental is closed from the "FT" lead through the normal contacts of (AV2), operated (FO3), normal (FO2), operated (S6), normal (CL4) normal (FS1), winding of (MTG) or (TG), operated or normal (CR5), normal (CI2), 14,500 ohms resistance, normal (CL4), operated (S6'), operated or normal (CR4) and operated or normal (CR3) to the "FR" lead.

P.C.I. AND OPERATOR CLASS CALLS

During Trunk Test the fundamental is closed from the "FT" lead thru the normal contacts of (AV2), operated (FO3), normal (FO2), operating winding of (OF), normal (FS1), winding of (TG), normal (CR5) and (CI2), operated (CL4) and (S6'), operated or normal (CR4) and operated or normal (CR3) to the "FR" lead.

The (TW) relay is operated when the sender is connected to a trunk which normally has reversed battery and ground, such as, Permanent Signal and Vacant Code. With (TW) and (S6) relays operated the (OF) primary winding is shunted, thus preventing its operation.

TRUNK TEST

If The call is routed thru Crossbar Tandem or a Two Wire Office then this will be the second Trunk Test made by the sender. The first being called Office Test in order to distinguish between the two tests. This time, however, the Trunk to the called office is tested and of necessity, the trunk to Crossbar Tandem or the Two Wire Office is tested a second time.

If the call is routed direct or thru F.S. Tandem the trunk is tested for the first time when relays (S6) and (S6') operate.

OPERATOR CLASS CALLS OS 209-1

When the fundamental is closed the (TG) relay operates from battery and ground in the trunk circuit. The "Line" relay in the trunk cct. operates in series with (TG). The operation of (TG) operates (TG1) which operates (TG2). With (S6) and (CL4) operated and (CL2) normal the operated (TG2) operates (AV1). This causes the sender to advance and cut the DJ thru, so that the subscriber is connected to the Trunk. To prevent the "Line" relay in the trunk cct. from releasing, while this action is taking place, a 500 ohm resistance is bridged across the "FT" and "FR" leads by the operated (AV2). The operation of (AV2) and the release of the sender is covered on OS 212-1.

CALLS TO MANUAL AND F.S. TANDEM OS 209-1

The (TG), (TG1) and (TG2) relays operate in the same manner as previously described. When (TG2) operates it operates (CI1) thru the operated (S6), (CL4) and (CL2) relays. (CI1) operates (CI2). The fundamental is now transferred from the normal (CI2) to the operated (CI1) and (TG2) relays OS 208-1. The (TG) does not release while this transfer is taking place. The "Line" relay in the Manual of Tandem office trunk circuit, operates in series with (TG) to indicate that a call is waiting on the trunk. In the Tandem office the trunk is connected to a sender. In a manual office the trunk is connected to a Call Indicator control circuit, either automatically or when the Operator depresses the assignment key associated with the trunk.

Battery and ground is disconnected from the trunk when the above circuit action takes place in the Manual or F.S. Tandem office. This releases the (TG) relay. If the trunk is assigned before (CI1) and (CI2) relays operate, then (TG1) holds to the normal (CI2) thus insuring the operation of (CI1) and (CI2) relays. The release of (TG) and the operation of (CI2) releases (TG1) which releases (TG2). The (CI1) and (CI2) relays remain operated. The fundamental is now closed thru the operated (CI1) and normal (TG2) to the P.C.I. pulsing circuit OS 207-1. Detailed circuit operation on a P.C.I. call will be covered later.

FULL SELECTOR CALLS OS 209-1

Battery on the Tip and ground on the ring of the Panel or Crossbar Incoming Trunk circuit operates (TG) or (MTG). The Line relay in the trunk cct. does not operate at this time due to the high resistance of the fundamental circuit. When (TG) operates (TG1) and this operates (TG2) or the operation of (MTG) operates (TG2) and this operates (TG1). (TG2) operates (O), (BO) and (FO) thru the operated (S6) and normal (CL4). (FO) operates (S1) thru the normal (S1') to (S5') relays. The operation of (S1) operates (FO2).

On certain selections involving panel selectors (FO1) is used to operate (FO2) instead of operating (FO2) directly. The slow release (FO1) is used to increase the open period between fundamental closures by approximately .065 seconds to allow time for the slow panel circuit to function. When (FO2) operates it opens the fundamental and releases (RC) and (FO3). The release of (FO3) also opens the fundamental and releases the holding path of (TG1), and the locking path of (O), (BO) and (FO). When the fundamental is open (TG) or (MTG) is released. The release of (FO) allows (S1') to operate in series with (S1). The operation of (S1') releases (S6) and (S6') and operates (FS1) and (FS2). (FS1) locks and holds (FS2). The release of (S6') releases (FO2) causing (RC) and (FO3) to operate. This closes the fundamental for Incoming Brush Selection.

INCOMING AND FINAL SELECTIONS

FUNDAMENTAL CCT. OS 207-1

During Incoming and Final Selections and Incoming Advance the fundamental is the same. The "FT" is closed thru the normal (AV2), operated (FO3) normal (FO2), operating winding of (OF) in parallel with its non-inductive winding, operated (FS1), winding of (STP), normal (BO), operated (FS2) operated or normal (CR4) and (CR3) to the "FR".

INCOMING BRUSH SELECTION OS 209-1

Incoming Brush Selection is made with (S1) and (S1') operated. It follows trunk test without delay for dialing, starting when (FO3) operates to close the fundamental.

Without the 14,500 ohms resistance in the fundamental the "Line" relay in the Trunk cct. operates in series with (STP). (OF) does not operate unless reversed battery and ground is received. This is covered on OS 211-1. When the "Line" relay in the Trunk cct. operates it starts circuit action in a Crossbar Office which results in connecting the trunk to a F.S. terminating sender. In a Panel Incoming Trunk cct. the "Line" relay prepares the Incoming Selector for Incoming Brush selection. The (STP) does not release while this action is taking place in the terminating office.

When the Panel Incoming Selector or Crossbar Terminating Sender is ready to record Inc. Brush Selection, ground pulses are connected to the "FT" which alternately shunt the (STP) and permit it to reoperate. Each time a pulse is received the (STP) operates a pair of counting relays, which lock. Each succeeding pulse operates the next lower numbered pair until all counting relays included in the selection have operated. The point at which the count starts is determined by the Thousands digit dialed.

When the last set of counting relays operate, which is always (O), (BO) and (FO), it indicates that the required number of pulses have been recorded. (BO) opens the fundamental to stop any further pulsing in the terminating office and to prevent (STP) from reoperating.

INCOMING GROUP SELECTION OS 209-1

The operation of (FO) advances the sender for Incoming Group Selection by operating (S2). The operation of (S2) operates (FO2) and this releases (RC) and (FO3). (FO2) and (FO3) make additional breaks in the fundamental and cause the release of all counting relays. When (FO) releases, (S2') operates and this releases (S1) and (S1'). (S1') releases (FO2) if the H hold magnet is operated. If the H hold is normal then (FO2) is held until the Hundreds digit is dialed. When (FO2) releases it operates (RC) and (FO3). The fundamental is now closed for Incoming Group selection. The (STP) and counting relays operate in a similar manner as described for Incoming Brush Selection, (FO) advancing the sender by operating (S3) and (S3') for Final Brush Selection.

REMAINING SELECTIONS OS 209-1

Final Brush, Final Tens, and Final Units are made in a similar manner to Incoming Brush and Group Selections. If (CL1) is normal then (FO1) will operate between selections but if (CL1) is operated then (FO2) will operate to open the fundamental between selections. When the sender reaches Final Tens selection the fundamental is held open, if the Tens digit has not been dialed. The operated (S4) operates (FS3) which locks to (FS1). The function of (FS3) will be covered on OS 210-1. The fundamental is held open when (S5) operates if the units digit has not been dialed, indicated by the normal (STL), or if Coin Test or Two Party Test is not satisfied, indicated by the normal (CCT) or disagreement in the setting of the (TP1) and (TP2) relays. After Final Units selection the (S6) and (S6') operate for Incoming Advance. This is covered on OS 211-1.

DISCHARGE OF TRUNK CABLE OS 207-1

If relay (CR5) is operated, then just before the fundamental is closed thru the (STP) for Final Brush selection, the following circuit exits from the "FT" lead thru the normal (AV2) and (FO3), 11,000 and 14,500 ohms resistance, operated (CR5), normal (S4), operated (S3), operated or normal (CR4), and operated or normal (CR3) to the "FR" lead. This path is closed only momentarily in order to discharge the trunk cable and avoid danger of a false pulse thru (STP) relay.

TRUNK CLOSURE OS 207-1

During Trunk Closure the "FT" is closed thru the operated (AV2), normal (FO2) and thru the 500 ohms resistance to the "FR" (Also see page 50). See (AV1) Relay operating path text OS 212-1.

OPERATION OF COUNTING RELAYS FOR FULL SELECTOR SELECTIONS OS 210-1

On full selector calls to Panel or Crossbar, Incoming and Final selections are made according to the number set up on the dial register switch. When office selections are required these selections are made according to the (OB-) and (OG-) relays operated by the marker.

Incoming and Final selections are determined by the location of the group of numbers, in which the called number appears on the Incoming and Final frames as shown below. Final tens and units selections are always the same as the last two digits of the number dialed.

IB	IG	Numbers
4	3	9500 to 9999
4	2	9000 " 9499
4	1	8500 " 8999
4	0	8000 " 8499
3	3	7500 " 7999
3	2	7000 " 7499
3	1	6500 " 6999
3	0	6000 " 6499
2	3	5500 " 5999
2	2	5000 " 5499
2	1	4500 " 4999
2	0	4000 " 4499
1	3	3500 " 3999
1	2	3000 " 3499
1	1	2500 " 2999
1	0	2000 " 2499
0	3	1500 " 1999
0	2	1000 " 1499
0	1	0500 " 0999
0	0	0000 " 0499

INCOMING FRAME

Numbers	FB
9900 to 9999	4
9800 " 9899	3
9700 " 9799	2
9600 " 9699	1
9500 " 9599	0
0900 to 0999	4
0800 " 0899	3
0700 " 0799	2
0600 " 0699	1
0500 " 0599	0
0400 " 0499	4
0300 " 0399	3
0200 " 0299	2
0100 " 0199	1
0000 " 0099	0

FINAL FRAMES

TYPICAL SELECTION (INCOMING BRUSH)

At the start of Incoming Brush Selection the following relays are operated on OS 210-1: (OF2), (DST), (RC), (SR1), (FS1), (FS2), (S1') (FO3) and (STP).

Assume thousands 4 has been dialed, then when the fundamental is closed by the operation of (FO3), the (STP) operates and operates the number (2) counting relay over the following path. Ground at the normal contacts of the (FS3) relay, operated (STP), normal (FS3), operated (OF2), normal (6'), normal (1'), operated (S1'), to the TH vertical crosspoints 4. The ② lead is tied to the ② lead at the armature of the (2') counting relay. The path continues thru the normal (2') and thru the winding of counting relay (2) to battery at (DST). This operates the (2) counting relay which locks to ground at (FO3). The (2') is shunted at this time.

When the first ground pulse is connected to the "FT" by the distant circuit is shunts (STP). The release of the (STP) allows the (2') to operate in series with (2). When ground is removed from the "FT", (STP) reoperates and operates the (1) counting relay thru the operated (2') and (RC). The (1) counting relay locks and the (1') is shunted. When (STP) releases on the second pulse it allows (1') to operate in series with (1). The operation of (STP) the third time operates (0) thru the operated (1'). When the third ground pulse shunts (STP) it allows (BO) and (FO) to operate in series with (0).

The (BO) in operating opens the fundamental and thereby stops the selection in the distant circuit and prevents (STP) from reoperating. (FO) in operating will advance the selection sequence circuit causing the release of (FO3) and in turn the counting relays. When (S2) and (S2') have operated the fundamental will be closed by the release of (FO2) and the operation of (FO3). The (STP) and counting relays are now ready for Inc. Group Selection.

OFFICE "A" OR "B" INDICATION DURING INCOMING GROUP SELECTION

To provide for completing calls over a group of trunks common to two crossbar offices (known as office "A" and office "B") the OS will allow the normal number of pulses to be sent during Inc. Group Selection to indicate office "A" but will add five pulses to Inc. Group Selection to indicate office "B". This is controlled by the (SD1) relay, which is operated by the Marker if the called office is the "A" office but is not operated if the called office is a "B" office.

Assume the called office is a "B" office and the number dialed is 4500. The incoming group selection for 4500 would be 1, which normally requires 2 pulses. With (SD1) normal, however, the sender will allow 5 pulses to be added making a total of 7 pulses sent by the Crossbar Terminating Sender. The Terminating Sender records the number of pulses which it sends and as there are now groups above 3, and 7 pulses will indicate office "B" as well as Inc. Group 1.

The circuit action in the OS for the above example is as follows: When the fundamental is closed at the start of Inc. Group Selection, (STP) operates. The operation of (STP) operates the (1) counting relay thru H5 and TH4 crosspoints. The (1) locks to the operated (FO3) and when (STP) releases on the first pulse (1') operates in series with (1). The next operation of (STP) operates the (6) counting relay thru the normal (SD1). The release of (STP) allows the (6') to operate in series with (6). If (2), (3) and (4) had been operated they would release when the (6) operated in order to be used again. The third time (STP) operates it operates the (5) thru the operated (6') and this releases (RC). The (5') operates in series with (5) when (STP) releases. Pulsing continues in the same manner until the (2) and (2') have operated. With (2') operated and (RC) normal a path is closed to operate (0) when (STP) operates for the seventh time. When the next ground pulse releases (STP) the (BO) and (FO) operate to signal the end of Inc. Group Selection and to advance the sender for Final Brush Selection.

REMAINING SELECTIONS

Final Brush Selection is made with relays (S3) and (S3') operated. The counting loop is steered by (S3') to the H vertical and then thru the crosspoints to the counting relay where the count will start.

Final Tens Selection is made with relays (S4) and (S4') operated. This time the counting loop is directed to the T vertical, by (S4') and then again by (S4). Final tens selection requires from 1 to 10 pulses depending upon the digit dialed. If any digit from 0 to 4 is recorded, the (0) counting relay operates for the (0) selection or after (1') operates on selections 1 to 4. If any digit from 5 to 9 is recorded then the (6) counting relay operates instead of (0) in order to count the additional pulses required for selection 5 to 9.

The operation of (S4) operates (FS3) to reverse the contacts of (STP) during succeeding selections in order to increase the life of the (STP) contacts.

Final Units Selection, which is made when relays (S5) and (S5') operate, requires from 1 to 10 pulses depending upon the units digit dialed. The counting loop is directed to the units vertical by (S5') and (S5) and then thru the crosspoints to the counting relays which operate in the same manner as described for Final Tens Selection.

OFFICE SELECTIONS

Office Brush Selection is made with relays (S4) and (S4') operated and relays (FS1) and (FS2) normal. The counting loop is directed to the (OB-) relays by the operated (S4') and normal (FS2). The number of counting relays included in the selection is controlled by the (OB-) relays, operated by the Marker as required. If (OB5) is operated, five additional pulses will be recorded by the OS and also by the Crossbar Tandem Sender. (OB5) is never used on calls thru T.W. office frames.

Office Group Selection is made with relays (S5) and (S5') operated and relays (FS1) and (FS2) normal. This time the counting loop is directed to the (OG-) relays and from there to the proper counting relay. The (OG-) relays are operated by the Marker as required. If (OG5) is operated, five additional pulses will be recorded. (OG5) may be used during office group selection on calls thru Crossbar Tandem or a T.W. office.

OFFICIAL CALLS (SPECIAL FOR CHICAGO) OS 210-1, 210-2

Since the code "OFF" is used for calls to the Local business office or the Main business office some means must be provided to route the call to the office desired. The (SG5) relay in the sender is used for this purpose.

When a subscriber dials the code the sender transmits this information to the Marker. The Marker operates the route relay associated with this code, establishes a connection to a trunk to the local office and operates relay (SG5) in the sender. If the number dialed is 9100 the call is completed in the regular manner and (SG5) has no effect upon the call.

If the number dialed is 9300, then the #3 crosspoints of the H vertical will close a ground from the normal (OF) thru operated (SG5) to the front contact of (STP). This will cause the pulsing of (STP) to be ineffective for operating the counting relays during incoming Brush Selection. The Crossbar Terminating Sender will continue to send and record ground pulses until 11 pulses have been recorded. As no selection requires more than 10 pulses the Terminating Sender recognizes 11 pulses as a "Telltale" condition and returns a reversed battery and ground pulse to the OS. This operates the (OF) relay in the sender, which is in series with (STP) at this time, causing the sender to make a second trial with a Marker. On second trial the sender grounds the "AR" lead to the Marker indicating the alternate route is to be used. The Marker will select a trunk to the alternate route, which will be a Franklin trunk, and the sender will proceed to complete the call to OFF 9300. Between first and second trial (SG5) relay was released along with other selection register relays OS 205-1. On second trial the Marker does not operate (SG5).

To provide for the possible rerouting of "OFF-9300" to a different trunk group, for example "OFF-9100" Fig. AH and "BK" wiring will be installed. With A.M.A., also the (ORR) relay. The originating marker will be arranged to operate the (SG5) relay when the code "OFF" is received from the sender. If the numerical digits 9100 follow this "OFF" code the connection will be set up to the group of trunks corresponding to the "OFF" code in a regular manner as is desired. If, however, the numerical digits 9300 follow the "OFF" code, then with (SG5) relay operated and the (ORR) relay operated or the #3 crosspoint of the II vertical of the register switch closed, a path is closed from the back contact of the (OF) relay for grounding the front contact of the (STP) relay. This will cause the pulsing of the (STP) relay to be ineffective for operating the counting relays in the sender and the terminating sender is forced to "tell tale" after which it will return reverse battery prematurely to the originating sender. The sender will then proceed to make a second trial with a marker as is described under "overflow" and tell tale."

On the second trial, the marker will not cause the (SG5) relay to be operated and the marker will set the call up to the group of trunks corresponding to the desired reroute point, and not to the trunks for the code "OFF".

INCOMING ADVANCE AND OVERFLOW OR TELLTALE OS 211-1

Incoming advance is a reversed battery and ground pulse sent to the subscriber sender as an indication that the called number is registered in the Crossbar terminating sender, or that final selections are completed in a panel office. When the OS receives this indication, it prepares to close the DJ cct. thru to the trunk before restoring itself to normal.

INCOMING ADVANCE

Polarized relay (OF) operates only on reversed battery and ground. (STP) and (OF) are in the fundamental and both will operate on the incoming advance pulse OS 207-1. Relay (OF) operates on the primary and locks to its secondary winding. This same locking ground is extended thru previously operated (S6') and (FS1) relays to operate (IA) relay. The (IA) closes ground from the operated (STP) thru operated (OF2) to operate (O) relay; and when the terminating circuit advances and cuts off reverse battery and ground pulse, the (STP) releases permitting (FO) to operate. Ground from operated (FO) thru normal (OF1), operated (IA) and (ON3), operates relay (AV1) to advance the subscriber sender. This will be covered on OS 212-1.

Long trunks or some non-repeating panel incomings give so short a reversed pulse that (STP) may not fully operate, and relays (O) and (FO) could not operate. Relays (O) and (FO) are then operated thru the (IA) and (CR5).

OVERFLOW AND TELLTALE

The subscriber sender may receive reversed battery and ground at any time other than incoming advance due to any one of the following conditions:

> Two wire office selector or Crossbar Tandem Sender may indicate overflow because all trunks in the group are busy;
>
> Incoming selector may go to overflow because all final selectors in the group are busy;
>
> Two wire office selector or an incoming or final selector may go to *telltale due to trouble;
>
> The Crossbar terminating or Crossbar Tandem sender indicates telltale if it fails during selections due to trouble;
>
> A reversed trunk, due to trouble, may be detected at trunk test on an operator or P.C.I. class call, or when incoming brush selection is made on F. S. calls.

*Telltale is a panel term used to indicate the position of the selector if it failed during selections, due to trouble, and was driven to the top of the bank. The term is also applied to the same type of failure in a crossbar terminating sender.

The polarized relay (OF) will operate on any of the above conditions in turn operating the (OF1). It is the (OF1) relay that differentiates incoming advance from overflow or telltale. On incoming advance the (OF1) does not operate.

(OF) relay operates on its primary and locks to its secondary winding. The locking ground is extended thru normal (S6') during selections, or operated (S6') and normal (FS1) during trunk test, to operate the (OF1) relay. (OF1) operates (IA)

Counting relays (O) will operate from ground at the operated (STP) relay during selections, or thru the operated (CL4) and (S6') during trunk test on P.C.I. or operator class calls. Relays (FO) will operate when (OF2) finally releases.

Note: The (OF2) is slow release to allow time for the distant circuit to advance before the fundamental is opened by the OS.

Ground from the operated (FO) will be steered away from the (AV1) relay at the operated (OF1) to operate (FO1). (FO1) operates (FO2).

Operated (FO2) operates (AV2) which locks. Relay (FO2) also removes locking ground to (FO3) releasing it. (FO3) normal and (AV2) locked, if (CR5) is operated, removes ground to the (O) and (FO) relays releasing both. The release of (FO) is followed by the release of the (FO1) and (FO2). Relay (FO2) normal releases (AV3). Off-normal ground thru contacts of (AV2) operates (TR1). Relay (TR1) in operating releases the (DST) relay. Relay (DST) in releasing causes (DRL) to release, in turn removing ground from lead "LR" to the DJ circuit. Open "LR" lead releases the charging relay in the DJ circuit, previously operated from the marker, so that a proper charge relay can be set up on a subsequent marker trial.

Released (DST) also removes off-normal battery to the (OF) releasing it and in turn releasing (OF1) and (AV2).

When (AV2) releases it removes the shunt from (TR2) permitting it to operate in series with (TR1). (TR2) operates (DST) which again connects battery thru normal (DRL) to the "ST" lead signaling for another marker. Operated (TR2) grounds the "AR" lead notifying the marker to use the alternate route to the desired point, if there is one.

The subscriber sender, after receiving information from the marker, makes another attempt to complete the call.

(AV1) RELAY OPERATING PATHS, TRUNK CLOSURE AND SENDER RELEASE OS 212-1

When the subscriber sender has established a connection to the calling line, or has made all possible attempts to do so, relay (AV1) may be operated by one of the paths shown on OS 212-1.

Operated (AV1) operates (AV2) in turn starting the release of the slow release (AV3). The operated (AV1) connects ground to the "TR" lead to operate the (T) relay in the DJ cct. provided (LR) has not operated on an abandoned call. When DJ (T) operates it locks to the operated DJ (S1) and closes an additional ground, thru the 10 ohms resistance, to hold the LL primary and secondary hold magnets. The (T) relay also closes the tip and ring from the LL to the windings of DJ (S), which operates from the subscriber's short. The operated DJ (S) closes an additional ground to hold the (S1). The calling subscriber now controls the LL, DL and OL crosspoints and the sender can proceed to release from the call.

TRUNK CLOSURE

When (AV2) operates it closes a 500 ohms resistance across the Tip and Ring of the trunk thus providing a trunk closure bridge OS 207-1. The (CS) relay in the DJ is also bridged across the tip and ring of the trunk, at this time, by the operation of (T) in the DJ. On abandoned calls the (T) in the DJ is never operated, and, therefore, the sender must provide a trunk closure bridge. Trunk closure either from the sender or the DJ, operates the (A) or

"Line" relay in the distant trunk circuit as a signal that the DJ is connected to the trunk and the call can proceed. After the trunk closure signal has once been connected, it must be maintained until the subscriber disconnects. Therefore, on abondoned calls, after the distant trunk or selector circuit advances, it releases when the sender releases.

SENDER RELEASE

In addition to the above circuit action the operated (AV1) causes the release of the F Hold magnet, in turn releasing the remaining Hold magnets in cascade.

The (AV3) is slow releasing to allow for the above operations before releasing the OS. When it has released fully (AV4) relay will operate to open locking path of (ON2). Relay (ON2) will release A, B, C and D Hold magnets in SSL, see OS 120-1. The release of (ON2) will release (ON1). It is the ($\overline{\text{ON1}}$) relay that breaks the off-normal grounds, restoring the sender to normal.

TWO PARTY TESTS AND CHECKS OS 213-1

These tests are made by the sender to determine whether the tip or the ring party of a 2MR line is making the call so the OM can set the DJ for the proper charge.

The sender makes two tests during MRP calls, one before dial tone is sent to the subscriber and the other before FU selection on panel or crossbar calls or before trunk test on PCI and operator class calls. The results of both first and second test must agree or the sender will stick.

Two party message rate lines cause the operation of (CS3) and (CS7) relays or (CS4) and (CS7) relays. This prepares the sender for two party test by causing a delay in the operation of (ON3) relay. This delay is measured by the condenser timed (TPT) relay.

When a line of another class calls, (ON3) operates at once from a contact of the (CS-) relay serving that class, and it remains operated throughout the call. This cuts through the tip and ring so that the (L) relay can operate as soon as (ON1) operates. When (ON3) is operated in this manner, it cancels two party test.

FIRST TEST - TIP PARTY CALLING

Relays (CS-) and (ON1) in operating connect the winding of (TP) to the tip and ring of the line. The 1000^w ringer ground from the tip party station operates (TP) and this operates (TP1) to register tip party for later transmission to the OM. (TP1) will lock for the duration of the call. With (TP1) operated and (ON3) normal the tip and ring will be closed to the TN coil. This is to discharge the line and prevent tapping the ring party bell when (ON3) operates.

Sufficient time for (TP) to operate is measured by the slow operation of the condenser timed relay (TPT). When the (CS-) relays operate, they connect ground through a normal contact of (ON1) to the secondary winding of (TPT), which will set it on its back contact. The condenser will have been discharged through this same contact of (ON1). When (ON1) operates after the registration of the frame number and class of service, it opens the ground to the secondary winding of (TPT), and connects ground to the primary winding. Current will start to flow through the primary winding, tending to move the armature over to the front contact, but current will also start to flow through the secondary winding to charge the condenser. The secondary winding being stronger, the relay will hold to its back contact for a short time, but as the condenser charges the secondary current decreases until finally the armature will move to close the front contact, then relay (ON3) will operate and lock through the normal (STL).

With (ON3) operated, ground is connected through a normal contact of (STL) to the secondary winding of (TPT), restoring that relay to its back contact and discharging the condenser. Relay (ON3) operated also disconnects the tip and ring leads from the winding of (TP) releasing it, and connects these leads to the (TN) repeating coil and (L) relay. The (L) relay can now operate and proceed to give the subscriber dial tone.

SECOND TEST - TIP PARTY CALLING

When dialing has been completed, relay (STL) operates. This releases (ON3), opens the ground to the secondary winding of (TPT), transfers the contact of (TP) from the winding of (TP1) to that of (TP2) and opens the circuit just described for discharging the line through the (TN) repeating coil and a contact of (TP1). The release of (ON3) connects the tip and ring again to the winding of relay (TP), disconnecting them from the (TN) coil and the (L) relay. (ON3) also bridges the front contact and armature of (L) so that the release of (L) will be without effect, (SR) holding up. When (TP) operates it operates (TP2) which locks. The cable will again be discharged, this time by the operated (TP2) and normal (ON3).

Sufficient time for relay (TP) to operate is again measured by (TPT). The breaking of ground from the secondary winding of (TPT) by the operation of (STL) does not at once stop the flow of current in that winding, but simply starts it to charging the condenser. When the condenser is charged, (TPT) makes on its front contact and operates (ON3) again. This time (ON3) neither locks or restores relay (TPT) to its back contact, both these circuits having been broken by operation of (STL). With (TPT) on its front contact, it continues to hold (ON3). Relay (ON3) operated transfers the "T" and "R" leads from the winding of (TP), releasing it and connects these leads to the (TN) coil and the (L) relay. (ON3) also removes the bridge from the contacts of the (L) relay. From this point on the call proceeds in a normal manner.

On Crossbar calls the (FO2) relay is held operated, and on Panel calls the (FO1) relay is held operated, following FT selections and before FU selections, until (TPT) reoperates for the second test and until (TP1) and (TP2) are both operated or both normal. On PCI or Operator class calls, before trunk test is made, the (FO1) is held operated under the above conditions.

If the first and second tests do not agree or if (TPT) fails to operate, the fundamental is held open by the operated (FO1) or (FO2) causing the sender to time out and signal the sender monitor or give a stuck sender time alarm.

INDICATION OF RING PARTY CALLING ON BOTH TESTS

After the second test if both (TP1) and (TP2) are normal, indicating a ring party calling, the call proceeds normally up to the operation of (AV4) relay, which releases (ON2). (ON1) does not release when (ON2) releases, as a path is closed to lock (ON1) thru normal (TP2) and (TP1), operated (AV1), to ground at the operated (CS-) relays. Relay (AV4) in operating connects ground to the secondary winding of (TPT) causing it to break its front contact thus releasing (ON3). (TP) now operates thru normal (ON3), operated (AV4), thru the 3050^W resistance, normal (TP2) to ground at the normal (TP1). This tests the ability of the (TP) relay to operate under extreme line conditions. (TP) operates (TP2) which breaks the circuit just described for holding (ON1) and also breaks the circuit to the winding of (TP). Until (TP) releases it holds (ON1) thru the locking contacts of (TP2). If this operating test of (TP) fails, or if on any call (TP) sticks up, (ON1) will be held until released manually. However, the call will be permitted to go thru.

COIN TEST OS 214-1

This circuit is arranged to test for the presence of a coin on the line or a false ground applied to the line for the purpose of obtaining free service.

When coin test is required it is indicated by the setting of the (CS-) relays and is made after dialing is completed. Coin lines cause the operation of (CS0) or (CS1) relays with either the (CS6) or (CS7) relays making a total of 4 coin classes. When more than 4 classes are required, the (CS2) relay is used with (CS6) or (CS7).

Coin test is cancelled on calls from non-coin lines, on calls from coin lines to special codes (L.D., L.T.D., P.S., etc.) and on calls to zero operator from CBSS nickel last lines.

COIN TEST CANCELLED

On calls from non-coin lines the (CTR) relay is not operated by the (CS-) relays. With (CTR) normal, a path is closed to operate the (CCT) relay when (DRL) operates. (CCT) locks to prevent its release if (DRL) is released by a second or third trial.

On certain operator class calls from coin lines, the sender receives an indication from the Marker that coin test is to be cancelled. This is indicated by the operated (CL3) and normal (SD) thus causing the operation of (CCT) when (DRL) operates. The (CTR) is operated from the (CS-) relay but has no function on this type of call.

In case the call is abandoned, the (SR1) relay releases after the (L) releases. This closes a path to operate (CCT) when (DRL) operates.

The operation of (CCT) relay by any of the above means prevents the other coin test relays from being brought into action and also opens the operating path of (FO1) or (FO2), thus closing the fundamental and allowing the call to proceed in the usual manner. OS 209-1

SATISFACTORY COIN TEST

When coin test is required the (CTR) relay will be operated and the (CCT) normal. On completion of dialing, (STL) operates and operates (CT).

GROUND TEST OF SUBSCRIBER'S LINE

The operation of (CT) disconnects the tip and ring leads from the dialing circuit (L) relay and connects these leads to the windings of the (CLR) and (GT) relays by operating (CT1). (L relay holds to DB & DC resistance ground).

The (CLR) serves to maintain switchhook control during coin test, and if it releases, indicating the subscriber has hung up, it shunts the (L) relay with a 52.5w resistance causing the OS to release. 110V negative battery thru the operated (CT1) will operate (GT) if there is a ground of from 0 to 1000 ohms on the line. (GT) will lock up thus signifying the satisfaction of ground test.

SOLID GROUND TEST OF SUBSCRIBERS LINE

When (GT) operates it is followed by (GTT), which disconnects the line from the windings of (GT) and connects it instead thru the windings of the (SGT) relay to ground and to negative coin collect battery without the resistances.

If the only ground on the line is the high resistance, one due to a coin in the box, (SGT) will not get enough current to operate.

The operation of the (GTT) breaks the operating circuit of the (CTR). The (CTR) relay releasing, will cause the operation of the (CCT).

Coin test is now fully satisfied and (FO1) or (FO2) will release and close the fundamental allowing the call to proceed in the usual manner.

UNSATISFACTORY COIN TEST

NO GROUND ON SUBSCRIBER'S LINE

Relays (CTR), (CT), (CT1) and (CLR) operate in the same manner. If there is no ground on the subscriber's line, the (GT) relay will remain normal.

The (CT1) in operating will connect ground to the armature of the SD interrupter and locking ground for the (H) relay. The interrupter cycles are counted on relay (H), (H'), (T), (T'), (U) and (U'), each cycle causing one pair of relays to operate and lock up. If a coin has not been deposited by the time (U') operates, then the next closure of the interrupter operates (CNL), which locks up and lights the coin lamp associated with this sender, at the sender monitor "A" position.

The sender monitor operator answers the signal by inserting the plug in the talking jack associated with the lighted coin lamp. Battery on the sleeve of the cord operates (MS) which in turn operates (MS1) and extinguishes the coin lamp. The (MS) and (MS1) in operating close the "T" and "R" leads to the talking jack and by-pass the circuit through the windings of the (CLR). (CLR) holds thru the "V" and "U" resistance when (MS) and (MS1) operate.

The operator requests the deposit of a coin and disconnects her cord from the talking jack, thus releasing (MS) and (MS1) and relighting the coin lamp. If a coin is then deposited the (GT) will operate and operate (GTT) which will release (CTR). The release of (CTR) will operate (CCT) and also cause the (FO1) or (FO2) to release, closing the fundamental and allowing the call to proceed.

The operation of the (CCT) will release the coin test relays that are operated, thus causing the release of the P.C.I. progress relays (used for timing) and extinguishing the coin lamp at the Sender Monitor Board.

SOLID GROUND ON SUBSCRIBER'S LINE

The coin test circuit will function as for satisfactory ground test and when the (GTT) operates the "T" and "R" leads will be closed to the windings of the (SGT). If there is a solid ground on the line (SGT) operates and operates (SGA). The slow release (CTR) will be held by (SGA) after (GTT) operates thus preventing the release of the coin test circuit. The timing circuit functions the same as before and when the sender monitor answers, (MS1) opens the locking path of (GT), causing it to release. This releases (GTT) and (SGA) and the release of (GTT) releases (SGT).

The operator has no way of knowing why the test failed, so she requests the deposit of a coin and disconnects the same as if no coin had been deposited. If the solid ground is removed before the second test is made, and a coin deposited instead, then a satisfactory coin test will be made and the call will proceed.

If the coin lamp is not soon extinguished, the operator will cause the sender to release by inserting the talking cord in the priming jack. This will be covered later on OS 217-1.

GENERATION OF P.C.I. PULSES OS 207-1 AND OS 215-1

When the call is to a manual office the subscriber's sender waits in trunk test until the trunk is assigned. Assignment is accomplished by opening and transferring the tip and ring of the trunk to the P.C.I. control circuit at the "B" end. There are now three relays bridged across the trunk at the PCI control circuit; the (SN-) which operates on negative pulses, either light or heavy, the (SN+) which operates on positive pulses either light or heavy, and the (MG) which operates only on heavy pulses either positive or negative.

When the tip and ring is opened during the assignment period the (TG-) relays in the sender release, causing the pulse generating circuit to function. This circuit causes a series of pulses (described below) to be transmitted over the trunk to the above named relays in the PCI control circuit. These relays respond to the pulses and cause lamp relays to be set up in the indicator thus displaying the called number, as registered on the crossbar switch.

Calls to F.S. Tandem are completed in a similar manner, except that pulses are also sent for the office code dialed, and are recorded in a sender instead of on lamp relays.

The C.I. pulsing circuit consists of start pulse relay (SP), pulse generating relays (PG), (PG1, (PG2) and (PG3), grounding relay (GR), pulse tip and ring relays (PT) and (PR), relay (12) which supplements lead $\boxed{1}$ and $\boxed{2}$ from the registered digits on the crossbar switch, relay (34) which supplements leads $\boxed{3}$ and $\boxed{4}$ from the registered digits on the crossbar switch, and final pulse relay (FP).

Relay (PG) is a non-biased condenser-timed polarized relay. It cannot be said to operate or release, but it closes its front contact when energized in one direction by its primary winding, closes its back contact when energized in the other direction by its primary winding and remains on either contact or between the contacts when not energized. When current is first closed through the primary in either direction, its force is more than neutralized by an opposing current in its secondary winding, the source of which is the charge or discharge of the timing condenser. When the condenser has been charged or discharged, current ceases to flow in the secondary and the primary causes the armature to move from one contact to the other. The actual time of operation varies somewhat with variations in voltage, resistance and relay adjustment. It averages about .069 second per single operation.

When the OM has sent selection information to the sender, the (CL2) relay operates and sends ground thru the normal (SP) relay contacts to ground out the 300^{w} resistance and operate the (PG) relay to its back contact. This ground also shunts condenser PG and discharges it. The discharge current momentarily delays the moving of the armature to the back contact, but is of no consequence at this time. When trunk test is made, relay (CI1) and (CI2) operate. Relay (CI1) operates (PG1) which in turn operates (PG2). (PG3) relay is shunted at this time.

After the trunk assignment key has been depressed and the (TG-) relays have released, relay (SP) operates to start pulsing. Relay (SP) removes the condenser shunt and the condenser begins to take on a charge. This causes a charging current to flow in the secondary winding keeping the (PG) armature against the back contact. At the same time the current thru the primary winding has reversed, the current now flowing from battery thru 300 ohms resistance primary winding of relay (PG), thru 3000 ohms resistance to ground. This primary current attempts to operate relay PG, but cannot do so until the charging current in the secondary winding has ceased. The condenser, when nearly charged, allows the PG to operate to its front contact. The operated (PG) releases the (PG1) and it in turn removes the shunt from the (PG3) and it operates. The (PG) also causes current to flow thru its primary winding attempting to release it; however, the condenser PG is discharging thru the secondary winding and holds it operated until the discharge current ceases to flow. When the condenser is nearly discharged, the (PG) relay is operated to its back contact. As the (PG) breaks its front contact it attempts to reoperate to its front contact thru the primary winding, but cannot do so because of the charging current in the secondary which continues to drive it to its back contact. When the (PG) makes on its back contact the cycle repeats. The (PG1) again operates and shunts (PG2) causing it to release. The next release of (PG1) releases (PG3). The next operation of (PG1) causes the (PG2) to operate and so the cycle repeats. Each complete cycle of (PG-) relay operations or four periods, is necessary to transmit one digit. Use Chart.

When operated, relay (PG1) grounds the "FR" lead for a positive or blank odd pulse, when normal it grounds the "FT" lead for a negative even pulse. Relay (GR) operates with relay (PG1) but slightly delayed.

The winding of relay (PT) is connected to lead $\boxed{1}$ of the dial register when relay (PG3) is normal and to lead $\boxed{3}$ of the dial register when relays (PG3) is operated. When relay (PT) operates, it connects 6500 ohms battery to the "FT" lead giving the light positive pulse. When relay (PT) is normal it connects ground through back contact of relay (GR) to the "FT" lead, so that both sides of the trunk are grounded momentarily to discharge the trunk capacity. Relay (GR) operates immediately after (PG1), after which the "FT" lead is open to give the blank pulse. For the first pulse relay (PG1) is operated in advance, but relay (GR) does not operate until relay (SP) operates to start the pulsing.

The winding of relay (PR) is connected to lead $\boxed{2}$ of the dial register when relay (PG2) is operated and to lead $\boxed{4}$ of the dial register when relay (PG2) is normal. Relay (PR) operates when a heavy negative even pulse is required and is normal when a light negative even pulse is required. Operated it connects 115 ohm battery to the "FR" lead, giving the heavy negative pulse. Normal it leaves 6500 ohm battery connected to the "FR" lead, giving the light negative pulse.

After the entire number has been transmitted, relay (FP) is operated. A blank pulse is sent after the fourth pulse of the unit digit with relay (PG) on its back contact, relay (PG1), (PG2) and (FP) operated and relay (PG3) normal. Then relay (PG) breaks its back contact, releasing relay (PG1) which lets relay (PG3) operate. Relay (FP) operated reverses the connections between the "FT" and "FR" leads and the contacts of relay (PG1), and also connects the 115 ohm resistance battery to the "FT" lead, so the release of relay (PG1) starts a heavy positive pulse. After the heavy positive pulse has lasted for the usual time of the pulse, relay (PG) closes its back contact. Usually that would operate relay (PG1), terminating the pulse and shunting relay (PG2); but this time, since relays (FP) and (PG3) are both operated, the back contact of relay (PG) is cut off from relay (PG1) and connected instead to release relay (PG2) directly. Relay (AV1) operates upon the release of relay (PG2) OS 212-1. The heavy positive pulse continues until the fundamental is broken by the operation of relay (AV2) OS 212-1.

The operation of relay (AV1) marks the completion of the sender's functions on the call. Besides starting the sender to releasing it also immediately releases the (CI) relays which stops the pulsing and opens the "FT" and "FR" leads from the pulsing circuit.

The (NT-) relays are required for extra contacts on the dial registers. They are used for call indicator calls (Fig. AX) and to free contacts for A.M.A. functions.

P.C.I. PULSE CONTROL CIRCUIT OS 216-1

As has been explained under Generation of PCI Pulses, leads $\boxed{1}$ $\boxed{2}$ $\boxed{3}$ $\boxed{4}$ $\boxed{6}$ and $\boxed{5}$ are connected to the (PG) relays from dial register crossbar switch. The leads which are grounded for a particular number depend upon the pulses required for that number. For example, if the pulses required were positive, heavy negative, blank, heavy negative, leads $\boxed{1}$ $\boxed{2}$ and $\boxed{4}$ would be grounded to operate relays which would produce these pulses.

When a PCI call is routed through tandem and the called number is under 10,000, relays (STB) and (STB') will have been operated in advance. When a PCI call is routed through tandem and the called number is 10,000 or over, relays (STA) and (STA') will have been operated in advance. When a PCI call is routed direct, relays (C) and (C') are operated in addition to (STA) and (STA') for numbers of 10,000 or over or (STB) and (STB') for numbers under 10,000.

The setting of relays (STA), (STA'), (STB), (STB'), (C) and (C') determine which vertical of the dial register crossbar switch will have ground supplied to its leads for grounding the necessary leads $\boxed{1}$ $\boxed{2}$ $\boxed{3}$ $\boxed{4}$ $\boxed{6}$ and $\boxed{5}$ for the desired number.

Assuming that the PCI call was direct with a number of 10,000 or over, relays (C), (C'), (STA) and (STA') would have been operated. Relay (CI1) would have operated on trunk test. Ground now would be placed on the (TH) vertical of the crossbar switch, under control of normal (TH) relay, to place ground on either, both or none of leads $\boxed{1}$ and $\boxed{2}$ depending on the requirements of the registered thousand number. Likewise ground is placed on the thousands vertical for leads $\boxed{3}$ and $\boxed{4}$ under control of relay (TH') normal.

When the first two pulses of the number have been sent, relay (PG2) releases operating relay (TH) and shunting relay (TH'). The operation of relay (TH) opens the ground supply for leads $\boxed{1}$ and $\boxed{2}$ of the thousands and closes the ground supply for lead $\boxed{1}$ and $\boxed{2}$ of the hundreds, in order to prepare the proper relays in the pulse generating circuit for these pulses when needed. When the thousands pulses have been completed, relay (PG2) operates allowing relay (TH') to operate and lock in series with relay (TH). The hundreds pulses are now sent and when relay (PG2) operates after the first two pulses relay (H) operates and then (H') in the same manner as the thousands relays functioned. This continues until relay (STB) and (STB') have operated at which time the final positive pulse is sent and then the pulsing circuit is opened and the sender starts to release as has been explained.

TIMING CIRCUIT AND TROUBLE CONDITIONS, WITH SENDER MONITOR OR AUTOMATIC TIMING OS 217-1

The subscriber sender timing circuit measures off the allowed times for the calling subscriber to start dialing, to finish dialing, and for the sender to release itself. If these timing periods are exceeded, the sender takes proper action to dispose of the call. (Note: This timing is separate and independent of "Timing for Station Digit" as explained in OS 206-1.)

This text describes the timing circuit and the procedure for permanent signal, partial dial and stuck sender conditions, in equipments where the two latter conditions are handled by a sender monitor. Time is measured by a timing interrupter which has a 20 second cycle, closing its contact for 10 seconds and breaking it for 10 seconds.

The relays of the timing and trouble circuits are as follows: (AL1), (AL2), (UL1) and (UL2) auxiliary to the dial register circuit, timing (TM1), (TM2), (TM3) and (TM4), permanent signal (PS), stuck sender (SS), monitor's lamp (ML), monitor's tip (MT), and monitor's sleeve (MS) and (MS1), the last required only if coin service is provided. Interrupter (SD) is used to flash the sender lamp when it is necessary to signal the monitor.

MEASUREMENT OF TIME INTERVALS

From (ON1) operated or elsewhere, ground is connected to the interrupter, the (TM) relays being normal, (TM1) operates when the interrupter is closed, (TM2) operates on the first break following, (TM1) releases on the second closure, and (TM2) releases on the second break. This 40 second cycle repeats as long as the interrupter remains grounded.

(TM3) and (TM4) are actuated by a front contact of (TM2). (TM3) operates in from 0 to 20 seconds after the connection of ground to the interrupter, (TM4) operates 20 seconds later and locks up, and (TM3) releases after 20 seconds more.

The ground connected to the interrupter is also the locking ground for the (TM) relays, and whenever it is broken all the operated (TM) relays release.

TIMING FOR DIALING TO START

The interrupter is connected to an off-normal ground lead through back contact of relay (AL1), and when (ON1) or (ON4) grounds that off-normal lead the (TM) relays start to function.

When the sender is seized the timing circuit starts to measure a period of from 20 to 40 seconds. If the first digit is registered within that time, the timing circuit is restored and starts again. Otherwise a permanent signal is registered and the call is routed to a permanent signal trunk.

If a digit is dialed in time it registers on the (A) and (AA) registers and (AL1) operates from a front contact of the (AA) hold magnet, to lock up for the remainder of the call. (AL1) breaks ground from the interrupter and any operated (TM) relays release. When they are all normal (AL2) operates, to lock up for the remainder of the call unless (ML) should operate.

If a digit is not dialed in time (TM4) operates and locks, and causes (PS) to operate and lock starting permanent signal routing. The timing continues and if the call is not disposed of in 40 seconds more, (TM3) and (TM2) both release, causing (SS) to operate and lock up. (SS) operates (ML) which calls in the monitor and opens the path from the "LR" lead to ground through the front contact of the (DC) relay ("Y" wiring only) so that the (LR) relay can substitute low resistance battery for ground on the "LR" lead and cause the district junctor to free the subscribers lines.

TIMING FOR DIALING TO FINISH EXCEPT STATIONS

When the first digit has been dialed the timing circuit starts again to measure a period of from 30 to 50 seconds. If the units digit is registered in that time, or the office code completed for an operator call without number, the timing circuit is restored and starts again. Otherwise the sender monitor is signaled.

When relay (AL2) operates during restoration of the timing circuit after the registration of the first digit, it grounds the interrupter through a back contact of (UL1). This starts the (TM) relay on another cycle.

If the units digit is dialed in time, it registers on the (U) register and (UL1) operates from a front contact of the (U) hold magnet, to stay up for the remainder of the call. When the dialing is completed on an operator call without numericals, relay (STL) is operated and (STL) operates (UL1), to stay up for the remainder of the call. (UL1) breaks ground from the interrupter and any operated (TM) relays release. When they are all normal (UL2) operates, to lock up for the remainder of the call or until (CNL) or (SS) operates.

If the dialing is not completed in time, (TM4) operates and locks in 20 to 40 seconds, and 10 seconds later (TM1) operates and causes (ML) to operate and lock. This calls in the monitor, but if the dialing is completed before the monitor answers, (UL1) operates, restores the (TM) relays and (ML), and the connection proceeds as if there had been no delay.

TIMING FOR RELEASE

When dialing has been completed except for a registration on the stations register, the timing circuit starts again to measure a period of from 30 to 50 seconds, unless the call is routed through a distant office selector or is of a C.I. class, when the period measured is from 60 to 80 seconds. If the call is not disposed of and the sender released in that time, the sender monitor is signaled.

When relay (UL2) operates on the restoration of the timing circuit after the completion of dialing, it grounds the interrupter and so starts the (TM) relays on another cycle.

If the sender is not released within 30 to 50 seconds (TW) and (CL2) normal (TM4) operates and locks in 20 to 40 seconds, and 10 seconds later (TM1) operates and causes (SS) to operate and lock. If the sender is not released in 60 to 80 seconds, (TW) and/or (CL2) operated, (TM3) and (TM2) release and with (TM4) locked up, cause (SS) to operate and lock. (SS) operates (ML) which calls in the monitor, but if the sender is released before the monitor answers, (SS) and (ML) release with all the other relays and the monitor signal is extinguished. The operation of the (TW) or (CL2) relay is determined by cross-connections in the marker. If the equipment beyond this sender times out and gives the sub-sender a reversed battery signal for a second trial the timing is momentarily reduced by the release of the (TW) or (CL2) relay and the (SS) relay may operate with "AP" option. With "AQ" option, the stuck sender timing is recycled when relays (TR1) and (TR2) operate for a second marker trial.

If a coin test is made and fails while the sender is timing for release, relay (CNL) operates to call in an operator. (CNL) releases (UL2), which stops the timing and restores the (TM) relays. If the coin test is then satisfied on a retest, (CNL) releases, (UL2) reoperates, and the timing for release starts again.

PERMANENT SIGNAL

If (PS) operates because dialing does not start in the time allowed, it calls in a marker and sends it the permanent signal indication. A connection is then made to a permanent signal trunk in the same manner as other operator class calls are completed. If the sender receives a trouble release signal from the marker the sender releases. With A.M.A. the sender connects to the maintenance recorder and transmits the calling line (PS) number, also a no trunk signal if all P.S. trunks are busy.

PARTIAL DIAL

If (ML) operates because dialing is not finished in the time allowed, it releases (AL2) and so releases the (TM) relays. It also grounds interrupter (SD) and switches its connection to flash the sender lamp and grounds the auxiliary signal circuit at the "A" switchboard.

STUCK SENDER

If (SS) operates because the sender is held beyond the time allowed after dialing is completed, it operates (ML), which releases (AL2) and signals the monitor as described.

(SS) ground the common "SS" lead to a stuck sender register operating the same. This ground is held on the common lead only while (ML) is operating and (AL2) releasing.

If (SS) operates because the sender is held 40 seconds after (PS) operates on a permanent signal, it operates (ML) to signal the monitor as above, but does not operate the stuck sender register because (AL2) has not been operated.

(SS) relay operated, removes direct ground from the "LR" lead ("Y" wiring only) which permits the (LR) relay to substitute low resistance battery for ground on the "LR" lead and cause the district junctor to free the subscriber's line.

MONITORING

A sender which is stuck due to failure to release, may be released as on an abandoned call if the subscriber hangs up either before the monitor answers the lamp or after she disconnects.

Upon observing a lamp signal the monitor will plug into the talking jack with a talking cord. Battery on "S" operates relay (MS), which extinguishes the lamp and cuts off the auxiliary signal while the plug is in the jack. (MS) operates (MS1) if furnished, the operation of (MS) or both relays opening leads "T" and "R" from the dialing circuit, so no further registration can be effected if a partial dial, and closing them to the talking jack. These relays close a local circuit to hold relay (L) operated, to prevent breaking the connection between line district and sender.

The monitor will request the subscriber to clear the connection by hanging up, and will then remove her cord plug. This failing, the monitor can frequently cause a release by inserting the talking plug momentarily in the priming jack. Ground from the tip of the talking cord operates relay (MT).

If relay (DST) has not operated, the dialing not having progressed far enough to call for a marker, (PS) will operate through front contacts of (MT) and (RA1) or (L2) and back contacts of (TR1) and (DST). The calling line will then be connected to a permanent signal trunk. The front contact of (RA1) or (L2) prevents the operation of (PS) if the sender is primed by mistake while idle.

If (DST) has been operated, either (DST) or (TR1) will be operated and ground through two front contacts of (MT) and a front contact of (DST) or (TR1), will operate (LR) if not already operated by the subscriber hanging up and (AV1) operated when (SR1) releases. If (LR) was not already operated the district will disconnect the calling line, releasing (L), (SR) and (SR1), and (AV1) will not operate until (SR1) has released. (AV1) will cause the disconnect of the sender as usual. The operating leads for (LR) and (AV1) are carried through back contact of (PS), so that they cannot operate on an early stuck sender release which operates (PS) and then (DST).

If the attempt to release a stuck sender fails, the lamp will flash again when the plug is withdrawn.

If the plug of the talking cord is left in the priming jack instead of being withdrawn immediately, or if it is inserted in the priming jack of an idle sender by mistake, it will hold the sender busy by (MT) operating (ON1) and will in time flash the monitor's lamp if it is not already flashing.

Whenever relay (MB) is operated the lamp burns steadily.

AUTOMATIC PRIMING AFTER TIMEOUT

When the (ML) relay is operated by either a partial dial or stuck sender condition, it locks to off-normal ground and operates the (MT) relay. The operation of the (MT) relay will light the (SS) lamp at the sender make busy frame and will automatically prime the sender as occurs with sender monitoring, when the operator inserts the talking cord plug in the priming jack.

If the attempt to release the sender fails, the (SS) will remain lighted and after an interval of 6 to 13 seconds, the associated delay alarm circuit (AL) lamp will light and the aisle pilot and audible alarms will operate. A make busy plug inserted in the (MB) jack operates the (MB) relay and also retires the alarm signals.

If Fig. AA is equipped, the (SS) lamp signal will be flashing instead of steady.

(TM) INTERRUPTER ACTION ON TIMING RELAYS

Step	Min. Time	Max. Time	TM (Int.)	TM1	TM2	TM3	TM4	Waiting for 1st Digit	Waiting for U. Digit	Waiting for Sender Release
1	0	10	B							(CL2) & (TW) Relays Normal, Short Timing
2	*1	20	M	O	S					
3	11	30	B	L	O	O	S			
4	21	40	M	S.R.	H	L	S			
5	31	50	B		R	L	O	+PS		
6	41	60	M	O	S	L	L		+ML	+SS
7	51	70	B	L	O	S.R.	L			With (CL2)&/or(TW)% Long Timing
8	61	80	M	S.R.	H		L			
9	62	81	B		R		L	+SS, +ML		+SS

Legend: - B = Break
M = Make
O = Operates
L = Locks
H = Holds
S.R. = Shunt Released
S = Shunted
* Relay operating time is less than 1 second.

SUBSCRIBER'S SENDER TIMING CIRCUIT WITH TIMED RELEASE OS 218-1

This circuit is used in offices with timed release senders. Various circuit action associated with the timing circuit will be covered in this text.

Time is measured by a timing interrupter (TM) which has a 20 second cycle, closing its contacts for 10 seconds and breaking it for 10 seconds. The relays for the timing and trouble circuits are: (AL1), (AL2), (UL1) and (UL2) auxiliary to the dial register circuit, timing (TM1), (TM2), (TM3) and (TM4), permanent signal (PS), tone (TN), stuck sender (SS) and register (REG).

MEASURE OF TIME INTERVAL

Whenever ground is connected to the interrupter with the (TM) relays normal (TM1) operates when the interrupter is closed, (TM2) operates on the first break following, (TM1) releases on the second closure (shunted by (TM2) and (TM) interrupter) and the (TM2) releases on the second break. This 40 second cycle repeats as long as the interrupter remains grounded.

(TM3) and (TM4) are operated by a front contact of the (TM2). (TM3) operates in from 0 to 20 seconds after the connection of ground to the interrupter. (TM4) operates 20 seconds later and locks up, and (TM3) releases after 20 seconds more.

The ground connected to the interrupter is also the locking ground for the (TM) relays, and whenever it is broken all operated (TM) relays release.

TIMING FOR DIALING TO START

Operation of the (ON1) connects off-normal ground through back contacts of relays (SS) and (AL1), and the (TM) relays start to function.

The timing circuit starts to measure a period of from 20 to 40 seconds.

If the first digit is registered within 20 to 40 seconds the timing is restored and starts again due to the operation of the (AL1).

If the (AL1) does not operate, a permanent signal is registered and the call is routed to a permanent signal trunk. (See Permanent Signal).

When the first digit is dialed it is registered on the (A) and (AA) register and the (AL1) relay operates from the (AA) hold magnet, to lock up for the remainder of the call. The (AL1) breaks the ground to the timing circuit and any operated (TM-) relays release.

TIMING FOR DIALING TO FINISH

When the first digit has been dialed the timing circuit starts again to measure a period of from 20 to 40 seconds. If the units digit is registered within that time, or the office code completed for an operator call without numericals, the timing circuit is restored and starts again. Otherwise a disconnect tone is sent to the subscriber.

With the first digit being dialed and recorded and when the (AL2) relay operates on the restoration of the timing circuit, it grounds the interrupter through a back contact of the (UL1) relay. This starts the (TM-) relays on another cycle.

If the units digits is dialed in time it is registered on the (U) hold magnet and the (UL1) relay is operated to stay up for the remainder of the call.

The (UL1) relay breaks ground from the interrupter circuit and releases any operated (TM-) relays.

On an operator class call the (UL1) relay is operated from the (STL) relay.

With all (TM-) relays normal the (UL2) relay operates and locks up for the remainder of the call unless the (SS) or (TR1) relays should operate.

If dialing is not completed in time, (TM4) operates and locks and in turn operates the (REG) relay. (REG) operates the (TN) relay which locks to send out tone to the subscriber. The operation of the (TN) relay releases the (REG) relay.

The timing continues and if the subscriber does not hang up and release the sender in 20 seconds more circuit action takes place to release the sender as described under Partial Dial.

TIMING FOR RELEASE

When dialing has been completed except for registration on the station register, the timing circuit starts again to measure a period of 20 to 40 seconds unless the call is routed through a distant office selector, crossbar tandem, or is of a C.I. class, when the period measured is from 40 to 80 seconds. If the call is not disposed of and the sender released in that time, a disconnect tone is sent to the calling subscriber.

When the (UL2) relay operates on restoration of the timing circuit after completion of dialing, it grounds the interrupter and starts (TM-) relays on another cycle.

If the sender is not released within 20 to 40 seconds, with relays (TW) and (CL2) normal, (TM4) operates and locks, and operates the (REG) relay.

The operation of the (REG) causes the (TN) relay to operate and lock, release the (REG) and send out tone to the subscriber.

If the sender is not released in 60 to 80 seconds with the (TW) and/or the (CL2) relays operated, (TM3) and (TM2) relays release and with (TM4) relay locked up, cause relays (REG) and (TN) to operate. The timing continues and if the subscriber does not hang up and release the sender in 20 seconds more further circuit action takes place as described under Stuck Senders.

PERMANENT SIGNAL

If the (PS) operates because dialing does not start in the time allowed, it calls in a marker and sends it the permanent signal indication. A connection is then made to a permanent signal trunk in the same manner as other operator class calls are completed.

The operated (PS) relay, locks to off-normal ground, operates relay (DST) calling in a marker, grounds marker leads A1 and A4, connects leads A2 and A5 to CK1 lead, and operates the (SS) relay after a delay if connection is not completed. The (SS) operates through a back contact of (AL2), front contacts of (TM1), (PS) back contact of the (AL1), the (SS) locks up and releases all timing relays except the (PS). When the (TM4) releases it lights an individual sender lamp and operates the auxiliary signal at the sender make busy frame.

If the (MB) is operated to keep the sender out of service the auxiliary signal lead is opened.

PARTIAL DIAL

If the (TN) relay operates because dialing up to stations is not completed in the time allowed it sends out to the subscriber a distinctive tone.

The (REG) relay operates (thru operated AL1), timing circuit, (AL2) and normal (SS) relays) momentarily in the process of operating (TN), and grounds a common partial dial register circuit long enough to operate the register.

If the calling subscriber does not hang up and release the sender within 20 seconds after (TN) operates, (TM1) relay will operate and then (TM2), causing the operation of (PS) if the dialing has not progressed far enough to operate the (DST) relay or (LR) if (DST) or (TR1) is operated. If the (PS) operates, the subscriber is connected to a permanent signal trunk. (See text on Permanent Signal.) If the (LR) operates the line is disconnected and the sender released as if the subscriber had hung up. (See Abandoned calls. OS 212-1.)

If the sender is not released in 10 seconds after the (PS) or (LR) relays operate, (TM1) releases and operates (UL1) relay which locks. This releases the (TM-) relays, operates (UL2) relay and starts timing for release as if dialing has been completed.

STUCK SENDER

If the (TN) relay operates because the sender is held beyond the time allowed after dialing is completed, or after an ineffectual effort to dismiss it following a partial dial, it sends out a distinctive tone.

With the operation of the (REG) (from the operated (AL1), timing circuit, operated (AL2) and normal (SS) relays) it in turn operates the (TN) and grounds the stuck sender register circuit long enough to operate the register except where the sender is stuck due to a coin failure.

If the calling subscriber does not hang up and release the sender within 20 seconds after the (TN) relay operates, the (TM1) relay will operate and then (TM2) causing the operation of the (LR) relay. This causes the disconnect of the line and perhaps the release of the sender as if the subscriber had hung up. (See Abandoned Calls OS 212-1.)

To release the sender on an abandoned call requires the operation of the (AV1) relay. If it is not operated in the normal manner after (LR) starts the disconnection, the (SS) relay will be operated 10 seconds later by the release of the (TM1), and that operates the (AV1) unless the (PS) relay is operated, when it is not desired to so disconnect. The (AV1) relay is prevented from operation when the (CTR) key is operated.

If the sender still fails to release, (TM2) releases after another 10 seconds and breaks the locking circuit for the (TM4) and (TN), which was partially broken by the operation of the (SS) relay.

The release of the (TM4) with the (SS) still locked up, lights the individual sender lamp, and lights the auxiliary signal at the sender make busy frame.

The operated (SS) relay removes direct ground from the "LR" lead which permits the operated (LR) relay to substitute low resistance battery for ground on the "LR" lead and causes the district junctor to free the subscriber's line. Shown in part on OS 252.

If relay (MB) is operated to keep the sender out of service the auxiliary signal lead is opened.

If the equipment times out and gives this sender a reverse battery signal for a second trial, the timing is momentarily reduced by the release of the (TW) or (CL2) relay and the (REG) may operate as the timing is recycled.

PRIMING CANCELLED

To prevent forced operation of the (AV1) relay and hold the sender for tracing trouble, the cancel priming key (CP) also called (CTR) key is operated. This opens the circuit through front contact of (SS) to the winding of the (AV1) relay, but in no way interferes with the operation of the (SS) or the lighting of the lamp.

If the key is restored after the (SS) relay has operated and locked up, the circuit is closed to operate (AV1) and to clear out the sender if possible.

SENDER SUPERVISORY METERS OS 219-1

This circuit is provided to operate load measuring meters and is used with timed release senders. The circuit is provided with two milliammeters, one (PD meter) to show the number of senders that have remained in one dialing position for more than the (SSM) (slow sender meter) interrupter cycle period of 5 to 12 seconds, the other (SC meter) indicates the number of senders that have not completed their function in 5 to 12 seconds, after dialing has been completed.

Part of the circuit action is associated with each sender in a group and the other circuit action is associated with the miscellaneous circuit for the whole group.

With the operation of the (AL1) relay, off normal ground is connected through the operated (RA1) relay, to the (SSM) interrupter.

The (B) interrupter contact closes ground to operate the (LM) relay locking to the off normal ground supplied by the normal (SS) and operated (AL1) and (RA1) relays.

Five seconds later (LM1) relay operates (if RA1) is still operated), locking to the operating ground and connects 1900 ohms to the partial dial meter circuit over the "PD1" lead.

If the (RA1) relay releases due to the dialing of another digit, the (LM) and (LM1) relays release and this cycle is repeated until the (UL1) relay operates.

With the operation of the (UL1) relay the 1900 ohm ground path is transferred to the (SC) slow completion meter over the "ST" lead and the timing cycle is repeated for slow termination.

The partial dial or slow completing meters indicate the number of sender closures.

In series with the 1900 ohm resistance and meters, are polarized relays and networks. The purpose of these relays is to indicate by visual and audible signal the number of senders in a partial dial or slow completion stage. The resistance network can be changed by connecting different resistance values as shown on the chart (OS 219-1). The secondary windings and their associated resistance tend to keep the polarized relays operated to the back contacts. The primary windings and their associated resistances will cause the polarized relays to be operated to their front contacts when the effect of the secondary winding is overcome when the correct number of 1900 ohm parallel resistances are connected to the "PD1" or "ST" leads.

Following is an explanation of the operation of polarized relays and associated signal circuit:

> The (PD1) relay secondary winding is biased by the (Y) and (Y1) resistance causing the relay to operate on 3% of the total number of senders, when these (3% of senders) have closed the "PD1" lead a delay in the partial dial position will be indicated.
>
> Assuming that timing is started when 2 senders are so delayed, the (Y) and (Y1) resistance required is 962 ohms (see chart). The (A) relay is operated when the F contact of the (SSA) interrupter closes and the (C) relay is operated from 10 to 20 seconds after relay (PD1) operates from the B contact of the (SSA) interrupter. The (SSM) lamp is lighted and the audible and visual alarm is operated.
>
> If the number of sender closures is quickly reduced from 2 to 1 assuming the (PD1) relay is biased to operate on 2 senders, the (PD1) relay will release and prevent an alarm.
>
> The (PD2) relay is biased to operate on 10% of the total number of senders, for which an immediate alarm is desired. If for example 7 senders are needed, 294 ohms is used for the (Z) and (Z1) resistance, the (PD2) relay will operate. When the (PD2) relay is operated, the (C) relay operates at once and the alarm and lamp function immediately.
>
> The (AR) key can be operated causing the (B) relay to operate releasing the (C) relay retiring the alarm signal, but holding the (SSM) lamp lighted till the (PD2) and (PD1) relays release.
>
> Observations should be made of the Supervisory Meters for excessive delayed senders at this time.
>
> The (SC) relay is biased to operate on 10% of the total number of stuck sender closures on the "ST" lead. It operates and releases from the number of senders as shown on the chart. The alarm will sound and (SSM) lamp light with the operation of the (C) relay. When the alarm is sounded it may be suspended by operation of the alarm release (AR) key. This operates the (B) relay which locks as long as any polarized relay remains operated, opening the audible alarm circuit but retaining the (SSM) lamp.
>
> Observations should be made of the Supervisory Meters and proper steps taken to determine cause if necessary.

TOLL DIVERSION

When toll calls dialed by PBX subscribers are to be denied machine completion, the crossbar system previously required these PBX lines to be segregated so that the service class signal could be established, which the originating marker translates for denied route. The use of centralized automatic message accounting, extended area dialing or FACD, makes it important to divert these PBX toll calls without requiring line segregation or service class marks, and without loading this denied traffic on the DSA switchboard.

This circuit has been arranged to provide a feature for toll diversion, which causes the sender to reverse the dialing tip and ring after dialing completion under control of a signal received from the originating marker on all toll calls requiring it. The reversal serves no purpose on non-PBX lines, however, on PBX lines equipped for toll diversion, a polar relay in the PBX trunk circuit responds to the reversal and diverts the call to the PBX operator. Crossbar central office equipment thereby is released early.

FULL SELECTOR CALL

When the dialed code indicates to the marker that the toll diversion signal is to be recorded, ground received from the marker via lead "TDV" operates the (TDR) relay and relay (TDR) locks to relay TDS normal.

The sender functions and when dialing is completed relay (STL) is operated. Relay (TDR) operated transfers the operating path of relay (AVI) to relay (TDC) normal, and closes the winding of relay (TDC) to operate in parallel with the (STL) relay. Relay (TDC) operated locks independently of the (TDR) relay to the locking circuit of relay (STL). Although the toll diversion feature is not involved in coin service at the present time, the operate path of relay (TDC) is brought through contacts of relay (CCT) when this circuit is equipped for coin service. This is done to give the feature greater flexibility. Figure BN is provided where the coin test feature, Figures E or AL, is not equipped to enable the operation of relay (TDC). The make before break contacts 1-2-3 top and bottom of relay (TDC) provide means for connecting battery and ground through the windings of the (TDS) relay in opposite polarity, and in parallel with the battery and ground on leads T and R at the (L) relay and coil TN without opening the circuit to the subscriber. The TDC relay fully operated removes the (L) relay and coil TN from the T and R leads, leaving relay (TDS) across the line, and providing battery to the tip and ground to the ring, constituting a line reversal.

With relays (TDR) and (TDC) operated, the operating path of relay (AVI) is opened, pending the operation of relay (TDS) and the release of relay (TDR).

Relay (TDS) operated places a holding ground to relays (LI) and (SR), maintaining switchhook supervision, and should the customer hang up, relay (TDS) will release releasing relays (LI) and (SR) to permit the (LR) relay to operate, enabling this circuit to release.

If a PBX customer equipped with a toll diverting trunk is attached the operation of a polarized relay in that circuit will cause the diverting trunk to open the tip and ring and transfer the PBX customer to the PBX operator or PBX tone diverting circuit. The tip and ring opened constitutes an abandoned call, and this circuit functions to operate relay (LR), as described previously.

In all other cases the line reversal has no functional effect, and when relay (TDS) operates relay (TDR) is released reclosing the operate path of the (AVI) relay. Relay (AVI) operated locks and removes ground from the bottom 2 contact of relay (TDS) releasing relays (LI) and (SR).

When this circuit is serving two-party lines a test is made, after dialing, for party verification. The test is started when relay (STL) operates by releasing the (ON3) relay.

If the code dialed necessitates the toll diversion feature, the (TDR) relay is operated and when relay (STL) operates the (TDC) relay operates in parallel with relay (STL) and locks around relay (TDR) to the locking circuit of relay (STL).

The operation of relay (TDC) removes relay (L) and coil (TN) from the tip and ring leads and closes battery to the tip and ground to the ring through the primary and secondary windings of the (TDS) relay. As relay (TDC) operates the sequence contacts will momentarily close the (L) relay winding and tone coil ground to the windings of relay (TDS). The (TDS) will start to operate and when the (TDC) relay is completely operated the (L) relay and (TN) coil are removed and the tip and ring closed to the (TDS) relay windings to hold relay (TDS). However the (ON3) relay is releasing due to the party test. The tip and ring opened by the released (ON3) relay will cause the (TDS) relay to release. The (ON3) relay released also provides a circuit to hold relays (LI) and (SR) operated preventing a false line release. At the completion of party test, assuming that the test was satisfactory, the (ON3) relay is reoperated and closes the (TDS) relay windings to the dialing tip and ring. The (TDS) relay operates and releases relay (TDR). With relay (TDR) released the operating path for relay (AVI) is closed in preparation for the ground signal received at incoming advance selection. Relay (AVI) operated, locks, and starts a series of operations.

CROSSBAR TANDEM

A tandem office is a switching point from which calls from originating offices can share common trunks to terminating offices. Manual, panel, and crossbar versions of such an office exist in the Bell System. Their use makes it unnecessary to provide direct trunk groups between points for which relatively light traffic is offered. For example, thru crossbar tandem suburban points can complete calls to any large office. A second use, to care for overflow traffic that finds all direct trunks busy, is a special feature when used with #1 crossbar originating offices. It is for this feature that other crossbar tandem units may be installed to supplement existing panel tandem crossbar tandem offices.

In manual practice if the trunks in the direct route are in trouble traffic is routed thru tandem. In panel practice under such conditions, by changing the translator or decoder cross connection such traffic is routed to the DSA board for disposal. However, in crossbar orig nating offices the originating marker if it finds all direct trunks busy on account of overflow conditions or because trunks are made busy on trouble conditions selects a trunk in an alternate route (thru crossbar tandem). The use of this feature makes it unnecessary to provide more direct trunks than can be efficiently used since overflow traffic can be handled on the alternate route. The end result is considerable savings on trunk cable plant and terminating office equipment.

An incoming trunk at crossbar tandem is permanently associated with a trunk relay equipment, a horizontal on a Trunk Link primary switch and a horizontal on the primary switch of a Sender Link. When the trunk is seized at the originating office, a short applied causes operation of trunk (A) relay which in turn grounds an individual start lead to the Sender Link controller. The controller determines which start lead is grounded, checks the links available for that trunk, and Senders that can be reached by the links. Selecting an idle link and Sender it sets up a connection between the incoming trunk on the horizontal of the link primary switch and the Sender on the horizontal of the link secondary switch, tests the continuity of the crosspoints involved, registers in the sender the Trunk Link on which the incoming trunk appears, and on signal from Sender disconnects itself leaving the link between the incoming trunk and sender under control of the sender.

On completion of registration of the desired office code (two digit in the case of Revertive senders and three digits in the cases of Multi-frequency and Dial pulse senders) the Sender seeks connection thru the Marker Connector to an idle Marker. It sends the office code and incoming frame (Trk. Link) information to the marker and receives class and compensating resistance information to be used in handling the call toward the terminating office. In the Marker the office code operates an individual route (R) relay. The contacts on this relay determine the class and compensating resistance information given to the Sender. Another contact determines the pair of Office Link frames on the secondary switch horizontals of which trunks to the desired terminating office are located. Steered by this "START" lead the Marker gains control of the pair of Office Link frames and as determined by a fourth contact (Trunk Level) on the operated Route relay brings in forty test (S1) leads of the outgoing trunk test group. Limiting its search between Group Start (GS) and Group End (GE) as determined by other contacts on the operated Route relay the Marker selects an idle trunk to the desired terminating office. During this time the Marker using the Trunk Link information it received from the Sender has gained control of and attached itself to the Trunk Link on which the incoming trunk appears. The Marker thru the Marker Connector, Sender, Sender Link, and Trunk circuit causes operation of an LC relay on the Trunk Link that extends test leads from the twenty verticals on the switch on which the incoming trunk is located to the Marker. At this, the Connector Stage of Marker action has been completed and the Marker causes the release of the Marker Connector. The Marker continues its connection to the Trunk Link and thru it, and the trunk circuit, to the sender and its connection to the Office Link and continues its action (Marker Stage) to set up a path (Channel) between the incoming trunk on the Trunk Link Primary and the outgoing trunk on the Office Link Secondary.

The switch train Trunk Link (Primary and Secondary) and Office Link (Primary and Secondary) should be considered as a unit since thru operated crosspoints on them a path (Channel), selected and set up by the Marker, is completed from the incoming trunk to the outgoing trunk. The "A" Link (Trunk Link primary vertical to Trunk Link Secondary Horizontal). The "B" Link or Junctor (Trunk Link Secondary Vertical to Office Link Primary Vertical). The "C" Link (Office Link Primary Horizontal to Office Link Secondary Vertical). Testing these links simultaneously in groups of twenty the Marker selects, tests, and sets up a Channel puts it under control of the Trunk circuit and releases itself.

Thru the connection thus established to an outgoing trunk the Sender when it receives registration of the desired telephone number makes selections or P.C.I. pulses the information to the terminating office sets the trunk circuit under control of the originating office and releases itself by dropping the sender link crosspoints.

CHAPTER 4

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CHAPTER 4

SECTION 1

PURPOSE, DESCRIPTION AND FUNCTIONS

Originating Marker Connector Circuit SD-25035-01

MARCH 1954

DESCRIPTION AND FUNCTIONS

GENERAL

This section covers a description of the originating marker connector frame and the purpose and functions of the circuit.

PURPOSE

The originating marker connector circuit is used in conjunction with subscriber and key pulsing senders for the purpose of connecting these senders to originating markers.

DESCRIPTION

The originating marker connector frame was illustrated in Chapter 1 and the assembly of the frame is shown on RM 4-1 of this section.

An originating marker connector circuit includes a maximum of 10 pairs of multicontact relays for connection to senders, a minimum of 3 and a maximum of 8 pairs of multicontact relays for connection to originating markers, and the associated control and alarm equipment. There are three connector circuits per marker connector frame.

Each originating marker connector is arranged to serve a maximum of ten subscriber senders, or a maximum of eight subscriber and key pulsing senders combined. The total number of senders in a connector is reduced to eight when any key pulsing senders are included to avoid delays in these connectors, as key pulsing senders handle heavier traffic than subscriber senders. For the same reason, not more than three key pulsing senders are included in any one connector circuit.

From a safety standpoint and to take care of emergencies, the key pulsing senders of a group are distributed over at least four marker connectors.

In general, the subscriber senders, located on a sender frame, are served by the same connector. No sender is served by more than one connector. The originating markers, however, are multipled throughout all the originating marker connectors, so that any sender may be connected to any originating marker. The circuits are so arranged that only one pair of sender multicontact relays and one pair of decoder marker multicontact relays in a particular connector can be operated at one time, and only one pair of originating marker multicontact relays belonging to a particular marker can be operated at one time.

The connector circuits of an office are divided into as many blocks as there are originating marker circuits, each block taking a different one of the originating markers as first choice. If that one is busy, the nearest idle one is selected, the markers being arranged in a defite order in a chain circuit.

FUNCTIONS

The originating marker connector provides means for connecting a sender to an originating marker. (RM 4-2)

Although serving a maximum of ten senders, the originating marker connector handles one sender at a time. If two or more senders associated with the same marker connector demand markers at the same time, the marker connector will allot the calls in a fixed order of precedence.

The sender circuit connects battery to the start lead to the marker connector circuit. If the marker connector is idle, or after it has served waiting calls in other senders, it operates a pair of multicontact relays for the calling sender. This closes a number of receiving, transmitting, check, and control leads between the sender and the marker connector. A pair of multicontact relays for a preferred originating marker are then operated, closing these leads through to the originating marker.

By means of these leads, the marker records the office code dialed, the district frame indication, the class of service of the calling subscriber, and other items of information. It returns to the sender the information it requires for completing the call, and after having found an idle trunk to the called office, sends a release signal to the sender. The sender then removes battery from the start lead to the marker connector circuit, releasing all operated relays in the marker connector and returning that circuit to normal.

Under certain trouble conditions or busy conditions, the originating marker may return a trouble release signal to the sender instead of the regular release signal. This causes the sender to release the marker connector as above, and also to close the start lead again to make another attempt, unless the trouble release signal is received on a third trial.

While the originating marker is functioning through the marker connector circuit as above, it holds itself busy to all other marker connectors. Release of the marker connector circuit, however, causes this busy condition to be removed, thereby permitting the originating marker to be reselected. Under these conditions, the decoder functions of the second call take place simultaneously with the marker functions of the first call, these marker functions consisting of the selection of channels and the closure of the path through the district and office link frames to the outgoing trunk.

A timing circuit in each marker connector gives an alarm and makes the associated senders busy in case the marker connector does not respond to a demand from a sender for connection with an originating marker or in case such a connection when established is held for an excessive length of time. Lamps are provided to indicate the sender and marker involved when a marker connector time alarm is given.

CHAPTER 4

SECTION 2

METHOD OF OPERATION

Originating Marker Connector Circuit SD-25035-01

MARCH 1954

METHOD OF OPERATION

SC 301

SENDER PREFERENCE - OS 301

When a 3-digit office code, an operator code, a permanent signal indication, or a sender load control condition is recorded in a sender, the sender connects battery to the ST and CBS leads to the connector circuit. Connection of battery to the ST lead causes the SS relay for the calling sender to operate.

> Relays SS, SA and SB are provided in the connector for each sender. These relays are wired per Fig. 3 for the first sender, Fig. 4 for intermediate senders, and Fig. 5 for the last sender. The operating path of the SS relay is traced through normal contacts of preceding SS relays or through its own normally closed make before break contact and operated contacts of a succeeding SS relay. This is to prevent its operation if a preceding SS relay is operated and all succeeding SS relays are normal, and is a factor in causing waiting senders to be served in rotation from the last to the first.

Connector circuit SA and SB relays for the calling sender operates.

> In order for the SA relay to operate, all succeeding SS relays must be normal, as the ground is furnished at the last one through a normal contact chain. This circuit arrangement prevents interference in case of simultaneous calls from senders, operating two or more SS relays, and together with the SS relay operating paths described above, insures that the senders are served in rotation from the last to the first.
>
> Operation of the SA and SB relays closes the receiving, transmitting, check and control leads from the sender to the common wiring on the marker relays DMA and DMB, so that the operation of a pair of these relays, described below, will connect the leads to a marker.

MARKER PREFERENCE - OS 301

Relays DS, CB, DMA and DMB are provided in each connector for each marker to which the connector has access. These relays are wired per Fig. 6 for the first marker, Fig. 7 for intermediate markers, and Fig. 8 for the last one.

In order to reduce the number of simultaneous calls for a particular marker and to distribute the calls as evenly as possible, different connectors are given different markers as first choice.

This is accomplished by dividing the connectors of the office, in as nearly equal parts as possible, into as many blocks as there are markers, and cross connecting the A punchings as follows: In the connectors of the first block, the A punching of Fig. 12 is cross connected to the B punching of Fig. 6, this figure being associated with the first marker. In the connectors of the second block, the A punching is cross connected to the B punching of the first Fig. 7, which is associated with the second marker. The remaining connectors are wired in a similar manner, those of the last block having their A punchings connected to the B punchings of Fig. 8. This is illustrated in Fig. 10, which gives the cross connections required in an office having twelve connectors and three markers.

In addition, as shown in Fig. 10, preference chains are provided for each marker throughout all the connectors. With respect to the connector equipment for the first marker (Fig. 6 in all connectors), the D punching of each connector of the office is cross connected to the E punching of the preceding connector, except for the first connector which has its D punching connected to ground at the CA punching. This provides a normal contact chain for the operation of DS relays, permitting any DS relay to operate if all preceding DS relays are normal, and preventing the operation of a DS relay if any preceding one is already operated. The E punching of the last connector (for the first marker) is connected to the DA punching, providing a path for the normally operated DA1 relay in the marker, with all the DS relays for that marker normal. There is a control circuit per Fig. 9 for each marker, for use with the connector equipment for that marker throughout all connectors.

A similar chain circuit in the opposite direction is provided for operating DMA relays, by connecting the H punching of each connector to the G punching of the following connector, except for the H punching of the last connector, which is wired to the GA ground. With this circuit arrangement, in case of simultaneous operation of DS relays, only the DMA relay in the higher numbered connector can operate, this circuit having the preference for the first marker. The G punching of the first connector is connected to the F punching, providing a path for the normally operated DA2 relay in the marker, with all DS relays normal.

In a similar manner chain circuits as described above are provided for the second marker throughout all connectors, except that the start and end points are changed. The D and G punchings of the first connector of the second block (connector No. 5 in the illustration) are connected respectively to the GA ground and the F punching. The E and H punchings of the last connector are wired to the D and G punchings of the first connector. The E and H punchings of the last connector of block A (connector No. 4 in the illustration) are wired to the DA punching and GA ground respectively.

With the cross connections given above, it is evident that the chain circuits for the second marker start at the first connector of the block having that marker as first choice, and end at the last connector of the block having it as second choice, the connectors being considered to be wired in a circle.

In a similar manner, the chain circuits for the third marker start at the first connector of the third block and end at the last connector of the second block.

In offices having more than three markers, and consequently more than three block divisions, additional chain circuits are provided, starting for each marker at the first connector of the block having that marker as first choice and ending at the last connector of the preceding block.

Operation of the connector circuit SA relay causes the operation of the connector DS relay.

> The DS relay to operate is the one for the marker that is first choice in the block and the calling connector nearest the GA ground. The path to operate the DS relay is traced from battery on the ST lead from the sender, operated contacts of the SA relay, ST lead, normal contacts of the GT relay, A punching, cross connected to a B punching, normal contacts of the CB relay, winding of the DS relay, and over the D-E chain to ground on the GA punching at the first connector of the block.

Marker circuit DA1 and DA2 relays for the preferred marker release.

> There is a control circuit per Fig. 9 for each marker. The DA1 and DA2 relays are operated, while the marker is idle, over the D-E and G-H chains. They release due to operation of the DS relay associated with the marker in any connector. Release of these relays starts the marker time measure, by connecting ground to the TM lead.

Connector circuit DMA relay for the preferred marker operates.

> The path to operate the DMA relay is traced over the G-H chain to ground at the last connector of the block having the marker as second choice. This circuit arrangement prevents interference in case of simultaneous calls in different connectors for the same marker, operating two or more DS relays.
>
> Operation of the DMA and DMB relays closes the receiving, transmitting, check and control leads from the connector, and consequently from the sender, to the associated marker.

Connector GT and GT1 relays operate. These relays are provided for the purpose of regulating traffic in the connectors. Marker circuit CBR, CBS and CBT relays of the preferred marker operate in parallel.

> Relays CBR, CBS and CBT are provided for each marker as required, so that the marker can hold itself busy at all connectors. These three relays provide a sufficient number of leads for an office having thirty connectors. In offices having less than thirty connectors, relays CBS and CBT are omitted if not required.

Connector circuit CB relays in all connectors associated with the selected marker operate, except the one in the connector which has seized the marker.

> These relays operate over individual CB leads grounded by the operated CBR, CBS and CBT relays. The CB relay in the connector which has seized the marker does not operate as it is short-circuited by the DMA relay operated.
>
> The operated CB relays open the paths to their associated DS relays and close them in each case to the CB and DS relays associated with the next choice marker. If any other DS relays associated with the same marker were operated, due to simultaneous calls for the marker, they release at this time.
>
> Due to the ~~GB~~ CB relays operated, subsequent calls in connectors having the busy marker as first choice will cause a DS relay for the second choice marker to operate, if that circuit is idle. In a similar manner, any marker upon being seized and operating its CB relays in the connectors causes calls that would otherwise be routed to them to make an initial attempt on the next choice circuit or the nearest idle circuit. The CB relays for the last marker extend the start leads to the equipment for the first marker.

Operated CB relays in busy connectors lock, except those in connectors in which all of the CB relays are operated.

> The operated CB relays lock to prevent a connector which has started to seize a second or later choice marker from abandoning that choice and reverting to an earlier choice circuit if one becomes idle at this time. The locking paths are not effective in connectors having all their CB relays operated, as this would cause interference with waiting calls not yet connected to markers.
>
> The sender is now closed through to the marker and the marker is made busy in all other connectors as the paths to its DS relays in these connectors are open. The connector circuit holds the connection until the marker has received the information from the sender, returned the decoded information, and determined that there is an idle trunk to the called office. It then sends a release signal to the sender.

RELEASE OF CONNECTOR CIRCUIT - OS 301

When the sender receives the release signal, it removes battery from the ST lead to the connector circuit, causing the connector relays to release starting with the SS relay. Finally, the operated CB relays in all connectors associated with the marker in use release.

> The release of these CB relays in the connectors other than the one that served this call will depend upon either of two other conditions. If any of these connectors has an SA relay operated at this time, and one of its other CB relays are normal, this CB relay will hold operated. This prevents the other connector from breaking off the start of a call to one marker if a lower preference marker should become available. However, if another connector has no SA relay operated or an SA relay operated with all the CB relays operated, then that connector's CB relay will release. Release of the CB relays makes the marker available for reselection by closing the operating paths for its DS relays.

SIMULTANEOUS CALLS - OS 301

The following examples are given to illustrate the action of the SS and DS relay chains with respect to simultaneous calls.

SIMULTANEOUS CALLS IN ONE CONNECTOR - OS 301

Any SS relay can operate if all preceding SS relays are normal or if a succeeding SS relay is operated.

If any two or more senders within one connector connect battery to their start leads simultaneously, with no other SS relays already operated, the two or more associated SS relays can operate. For example, if the first and last senders (Nos. 0 and 9 in the connector) call at the same time, the SS relay for the No. 0 sender operates as in regular operation. While it is operating, the SS relay for the No. 9 sender can also operate, closing its locking path before its operating path is opened by the SS relay for the No. 0 sender. Any number of SS relays within one connector can operate simultaneously as above.

In this case both SS relays remain operated but the only SA relay that can operate is the one for No. 9 sender. This sender thus has preference. When the No. 9 sender releases its SS relay, the SA relay for the No. 0 sender operates and that call proceeds.

ADDITIONAL CALLS WITH SENDERS WAITING - OS 301

In this case it is assumed that the SS relays for the Nos. 1 and 7 senders have operated simultaneously. The No. 7 sender in this case receives the preference. While the No. 7 sender is still engaged and the No. 1 sender is waiting, it is assumed that the No. 4 sender calls. The SS relay for the No. 4 sender operates through its own normal (make before break) contacts and through operated contacts of the SS relay for the No. 7 sender. The make before break springs permit the relay to operate through its own normal contacts and to lock.

With the SS relays for the Nos. 1, 4 and 7 senders operated, the SS relay for the No. 0 sender can still operate. Those for the Nos. 2 and 3 senders can operate through their own normal contacts and operated contacts of the SS relay for the No. 4 sender. The SS relays for the Nos. 5 and 6 senders can operate through their own normal contacts and operated contacts of the SS relay for No. 7 sender. The SS relays for Nos. 8 and 9 senders cannot operate under these conditions.

The senders associated with operated SS relays are served in order from the last to the first, each SS relay in releasing closing ground for the next preceding SA relay. If any senders connect battery to their start leads while a call is being served in a lower numbered sender (as for Nos. 8 and 9 senders in the above illustration), these senders operate their SS relay simultaneously after all senders with SS relays already operated are served and the lowest numbered operated SS relay has released. The preference then continues.

SIMULTANEOUS CALLS FOR ONE MARKER - OS 301

Any DS relay for an idle marker can operate if the DS relays in all preceding connectors, up to the ground end of the D-E chain, are normal or if a succeeding DS relay up to the DA punching end of the chain is operated.

If two or more connectors in the same block (or temporarily included in the same block due to marker busy conditions) connect battery to their A punchings simultaneously with no other DS relays for the marker already operated, the two or more associated DS relays can operate and lock. For example, if connectors Nos. 3 and 4 (Fig. 10) call at the same time, the DS relay of Fig. 6 for connector No. 3 operates and locks as in regular operation and the DS relay of Fig. 6 for connector No. 4 operates simultaneously, closing its locking path before its operating path is opened by the DS relay of connector No. 3. Any number of DS relays for one marker can operate simultaneously as above.

In this case the only DMA relay that can operate is the one for connector No. 4 and the DS relay of connector No. 3 releases when the CB relays operate, advancing the start leads.

MARKERS OTHER THAN FIRST CHOICE - OS 301

When a marker becomes busy, operation of its CB relays causes all remaining idle connectors having it as first choice to be temporarily associated with their second choice marker. For example, a call in connector No. 4 (Fig. 10) connecting to the first marker causes connectors Nos. 1, 2 and 3 to be temporarily associated with the second marker, together with connectors Nos. 5, 6, 7 and 8. Any of these connectors calling singly seizes the second marker. Simultaneous calls in these connectors operate their DS relays for the second marker and the preference starts at the connector nearest the ground end of the G-H chain as before. Under these conditions, if the second marker becomes busy, all remaining idle connectors are associated with the third marker, the preference being determined as before. In a similar manner, the last marker extends the start leads to the equipment for the first one.

If two or more connectors call simultaneously and their choices fall on different idle markers, all connections are made at once. If their choices fall on the same marker, the preferred connector seizes it as described above. The unsuccessful connectors connect to succeeding idle markers without appreciable delay, if there are any available, due to the CB relays in operating advancing the start leads.

If connectors call while all markers are busy, they are served as markers are freed, in regular order, depending upon the preference chains.

CONNECTOR TIME ALARM

TIMING FOR OPERATION OF DMA RELAY - OS 304

The connector time alarm circuit provides an audible alarm and indicates the sender and connector involved, if the connector circuit should fail to function properly within a certain period of time. The time measure starts when ground is connected to the CA1 interrupter by operation of the CA1 relay upon seizure of the connector. An additional ground is connected to the CA1 interrupter when the SB relay operates. This is to provide for alarm facilities if the CA1 relay should fail to operate or if the SB relay should fail to release.

> The CA4 relay operates in from 5 to 12 seconds after the CA1 relay operates, depending upon the position of the interrupter when the connector is seized. Ordinarily the connector circuit is released, releasing the alarm relays, before the expiration of this period of time. If the circuit is held, however, long enough to operate the CA4 relay, ground is connected to the C lamp for the connector circuit and the CT lead to the trouble indicator frame.
>
> There is a C lamp on the trouble indicator frame for each connector circuit used to identify the connector involved in a failure.

Ground on the CT lead operates the CT relay which starts the major audible alarm and lights a lamp to indicate that a connector has timed out. The release of the major alarm awaits the operation of the LORL key.

Operation of the BAT key on the trouble indicator frame causes the C lamp grounded by the operated CA4 and CA6 relays to light, indicating the connector circuit that timed out. An S lamp also lights, from ground on the SA relay operated, indicating the sender involved. There are ten S lamps, wired to all the connector circuits in common.

While the BAT key is operated, C and S lamps other than the ones indicating the failure may light momentarily, due to calls going through, but the ones involved in the trouble remain lighted steadily.

If the GT relay was operated or held due to false grounds on the GT or CP leads respectively, the loss of the operating battery when the CA6 relay operated would force the GT relay to release. With the GT relay normal this connector can serve calls without benefit of the sequence regulator even though there was a minor alarm as a result of the CA6 relay being locked operated.

TIMING FOR RELEASE OF CONNECTOR - OS 304

If the circuit functions properly up to operation of the DMA relay and consequently does not bring in the alarm as above, the first timing period is cancelled and a second one is started when the DMA and CA5 relays operate. This restart of timing permits a shorter timing interval before the connector alarm is sounded than would be possible if an over-all timing period were used. Also, the use of shorter periods with the restart serves as a check in case senders are delayed in engaging a marker.

When the DMA relay operates, it operates the CA5 relay and connects ground to the CA2 interrupter. The CA5 relay operated removes ground from the CA1 interrupter and releases the CA2 relay, if operated, thus cancelling the first timing period. The CA5 relay also connects ground to the C lamp.

The CA4 relay operates in from 5 to 12 seconds after the DMA relay operates. Ordinarily the connector circuit is released, releasing the alarm relays, before the expiration of this period of time. If the circuit is held, however, long enough to operate the CA4 relay, ground is connected to the CT lead for sounding the alarm. The identity of the connector and sender involved is shown as before when the BAT key is operated.

If no trouble is encountered during the call, the time measure ends when the DMA relay releases, removing ground from the CA2 interrupter and releasing the CA3 relay, if operated.

FALSE GROUND - LEADS "RO"-"TRL"-"RL" - OS 304

With the connector circuit normal the windings of relay GR are connected to leads "RO", "TRL" and "RL" for the purpose of detecting false ground on any of these leads. If the GR relay operates it locks and lights the GR lamp on the trouble indicator frame, indicating the type of trouble. Also lights the C lamp and sounds the major alarm.

When the trouble ground is cleared, relay GR may be released by the operation of the RLA key at the trouble indicator frame.

This check circuit is removed by the GRA relay when it operates from the SA relay, upon the selection of a connector. It is reconnected when the DMB relay releases, in order to prevent its use until after leads "RO", "TRL" and "RL" have been disconnected from the marker.

CONNECTOR TRAFFIC SEQUENCE REGULATOR - OS 303

In periods of heavy traffic when all markers are not in service, connectors may be delayed in seizing markers. In order to equalize these delays between the various connectors and prevent any connector from having extreme delays, a traffic sequence regulating feature is provided. Otherwise some connector having comparatively slow operating DS relays might be delayed for seconds while other connectors seized markers quickly.

The method used for regulating is to lock out of service any connector which has seized a marker until all other waiting connectors have each served one call. This is accomplished by gate relays GT and GT1.

When a call enters a marker and succeeds in operating a DMB relay, the GT and GT1 relays associated with the connector operate. When the sender releases the connector, the DMB relay releases and removes the operating ground for the GT relay. Now if some other connector is waiting for a marker to become idle, that connector and all others waiting have an SB relay operated, which provides a locking circuit for all connector GT relays operated.

The locking circuit for the GT relay is from battery in the trouble indicator circuit over the B lead, break contacts CA6, secondary winding of GT, make contacts GT1 and GT, common strap lead CP (the lead to a protective network being purely incidental) to all connectors which are waiting for markers, break contacts of their GT and GT1 relays, over GT lead to make contacts of SB relay, to GTG lead ground.

As long as a GT relay remains operated, the path from the start lead to the A punching remains open, so that its connector will not reseize a marker, until all GT relays in waiting connectors have been operated, at which time all GT relays are unlocked. The GT relays in connectors which are not serving calls at the moment then release, in turn releasing their GT1 relays. Now if any one of these connectors has a new call waiting, it connects locking ground to the common strap lead CP through the back contacts of the GT1 relay. Relay GT1 is therefore made a little slow release in order to permit all GT relays to release.

The operation of the GT relay opens the operating circuit for relay DS, but the DS relay has a holding circuit independent of the GT relay from the DMA relay until the sender opens the start lead.

MARKER MAKE BUSY - OS 302

A marker may be made busy at all connectors by the insertion of a short-circuited plug in the DB jack for the marker, this jack being located on the trouble indicator frame. This operates, in turn, the DB relay, the CBR, CBS and CBT relays, and all associated CB relays. The DB relay opens the DB lead to the marker, to prevent a time alarm.

A marker may be made busy at a single connector by means of a CB jack, also located on the trouble indicator frame. One of these jacks is provided for each appearance of each marker in the connectors. A plug put into the CB jack will not operate the CB relay if that particular marker is serving a call on that connector. The operate battery of the CB relay will be shunted until the DMA relay releases.

MARKER TIME ALARM

Any trouble which ties up the marker connector will give the connector time alarm, and if it also ties up a marker it will also give the marker time alarm. If a marker alone is tied up, as by a false ground on the DB lead, the marker alarm only will be given.

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CHAPTER 5

SECTION 1

PURPOSE, DESCRIPTION AND FUNCTIONS

Originating Marker Circuit SD-25016-01

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DESCRIPTION AND FUNCTIONS

GENERAL

This section covers a description of the originating marker, district link and office frames, and the purpose and functions of these circuits.

ORIGINATING MARKER FRAME

PURPOSE

The originating marker circuit is used to receive information from the originating senders, which it decodes, and then returns information to the sender, so that the sender can control selections at the terminating end over the outgoing trunk. The marker also selects a trunk to the desired office and establishes a path from the district junctor to the selected trunk as well as to transmit talking selection, charge or noncharge, and party information to the district junctor.

DESCRIPTION - RM 5-1

The originating marker frame consists of a two-bay frame for common equipment and one or more route relay bays as required. Each frame accommodates one originating marker circuit. The first bay of the common frame mounts all the relay equipment of the circuit except the multicontact relays. The second bay of the common equipment is arranged to mount the multicontact relays (except route relays) and associated terminal strips, fuse panel, and a number of decoder type cross-connection terminal strips. The route relay bay is arranged for 100 route relays (50 multicontact relays) and associated multicontact terminal strips and a number of decoder type, cross-connection terminal strips.

Terminal strips are provided on the common equipment bay to provide means for making a large number of cross connections which are more or less common for the whole frame. There is approximately the same amount of cross connection terminal space on the route relay bays. These are required for cross-connecting the 100 route relays mounted in the frame. A number of these terminal punchings are multipled from the common equipment bay to all of the route relay bays of a marker circuit, so that no cross-connections need to be made from one bay to another bay. It is also advantageous in making cross-connection changes, thereby minimizing interference with working codes. There are fourteen contact terminals and two winding terminals on each route relay which are cross-connected through these terminal strips.

The number of route relay bays varies for each individual job, depending upon the number of route relays required. In general, there is one route relay per office code used. However, for the routes requiring a large number of trunks (over eighty) two route relays will be used. Additional route relays are required for destinations which have an alternate routing. One group of trunks is usually used as an alternate route for several codes. There are a few special codes which have multiple routes in order to provide properly for the various classes of service. These require several route relays per code.

The most efficient use of these circuits is to have an originating marker group which would have the maximum number of district and office link frames, twenty each. This would provide, then, ample facilities for more than 10,000 line unit. Consequently, a number of 10,000 line units may be handled in one originating group of circuits. In order to handle this traffic, means have been provided for a maximum of eight originating markers and a maximum of thirty marker connector circuits, which in turn will accommodate 240 to 300 senders, depending upon the number of key pulsing senders used. Facilities are provided for connecting any one of the markers to a trouble indicator frame which is used to assist the maintenance men in locating trouble.

FUNCTIONS - RM 5-2, RM 5-3

As soon as the office code has been dialed into the sender, the sender obtains access to an originating marker through an originating marker connector.

The marker first checks the leads by which it is connected to the sender through the marker connector circuit for opens, crosses, and grounds and then records the office code which was dialed. At the same time, the district link frame number on which the district junctor involved is located and the class of service of the subscriber making the call are recorded. It also records, if the line is a party line, whether the call is from the tip party; and in case trouble has been experienced on earlier attempts by the sender, it records whether this is a second or third trial. In case this is a second trial, the marker is arranged to route the call over an alternate route if one is provided; otherwise, the regular route will be selected. On third trials, an overflow condition will always be returned to the subscriber.

From the above information, the originating marker transmits back to the sender through the same marker connector, information that the sender will require to complete the call, such as class of call, trunk compensating resistance, and panel office selections, if required. This is accomplished by the operation of a particular route relay for the code, operated under control of the office code recorded and class of service information received from the sender. This relay operates transmitting relays which ground a selection of leads to the sender. A talking charge relay, operated in series with the route relay, transmits the charge information to the district junctor.

Including zero operator and permanent signal, the marker has a capacity for 802 possible codes. However, arrangements have been made to accommodate another set of 800 codes by the so-called "extended area dialing." This means that the subscriber must prefix the office code by dialing 1-1. The sender in this case disregards the first pulse but records the second.

One of the principal advantages of the crossbar and panel systems over the step-by-step system is the flexibility of the trunking facilities. In crossbar and panel, the size of the trunk group to a particular office may be readily increased, decreased, or rerouted through a tandem point by changing the associated cross connections in the originating markers or decoders. In fact, the decoder portion of the originating marker is for the purpose of providing this flexibility. In crossbar, these cross connections for each code or destination are made in conjunction with the route relays provided for each code which is available to the subscriber on an automatic basis.

The next task of the originating marker is to locate an idle trunk to the office indicated by the office code. In order to accomplish this, it connects itself to the pair of office frames on which the required office trunks appear. It will be recalled, there is always an even number of office link frames in a crossbar office, these frames being arranged in pair. Each pair of office link frames, with respect to the outgoing trunks, is divided into "trunk levels", each trunk level including forty trunks, located alternately on the even and odd numbered frames. An outgoing trunk group to a particular destination may consist of the entire forty trunks of a trunk level, or it may consist of any smaller even number of trunks within a trunk level, or it may be divided into two or more subgroups appearing in the trunk levels of different pairs of office link frames.

The route relay operated for the call, in addition to controlling the information transmitted to the sender, associates with the marker the pair of office link frames on which the desired trunks are located, causes the sleeve leads of the trunks of the required trunk level to be connected to the marker, and determines the location of the desired trunks within the trunk level. The marker then tests these trunks, seizing and making busy the first idle one.

The district frame involved is connected to the marker under control of the district frame indication received from the sender. At this time, the primary select magnet associated with the district junctor is operated, the sleeve leads of the district links available to this district junctor are extended to the marker, and the secondary select magnets associated with the links are operated.

The district frame information and the office frame information, in combination, causes the operation of a certain junctor connector relay on the district link frame and the operation of a "pattern" relay in the marker. These relays are used to indicate the location of the office junctor circuits connecting the particular district frame to the particular office frame on which the selected trunk is located. On certain combinations of district and office link frames, it is desirable from a cabling and cross-connection standpoint to care for irregular locations of office junctors by blanking out the positions of certain office junctors which are not equipped in some particular cases.

The district link frame offers the district junctor a path to 200 office junctors, the junctors being divided into as many groups as there are office link frames, each group to an office link frame containing an equal number of junctors. The office link in effect offers the outgoing trunk, preselected by the marker, a path of 200 office junctors and in this case the office link frame has a group of junctors from each district link frame. The effect of this arrangement is of two primary-secondary combinations facing each other with the originating marker the agency for matching the paths between district junctor and outgoing trunk.

After selection of a trunk, the marker sends a release signal to the sender causing the sender to release the connector circuit. It also causes the district frame to extend to the marker the sleeve leads of the office junctors; and it causes the office frame to extend to the marker the sleeve leads of the office links which terminate at the office secondary switch on which the selected trunk is located and to operate the primary select magnets associated with these links. At this time, also, the office frame secondary select magnet for the selected trunk is operated.

The next problem is to connect this idle trunk to the district junctor on which the call is waiting.

In order to connect the district junctor to the idle outgoing trunk, which has just been chosen ("marked") by the marker, three paths must be connected in series between the two points. First, there must be an office junctor between the district and office frames. Second, the district junctor must be connected to an office junctor by means of a district link. Third, the office junctor must be connected to the outgoing trunk by means of an office link. Since there are a number of each of these paths which can be used on a given call, it is the duty of the marker to determine which set of three paths shall be used.

The decoder marker connects itself to the test leads of outgoing trunks and also to those of office links through the office connector. It obtains access to the test leads of district links and office junctors through the "district connector" located on the district frame on which the calling district appears.

In the originating marker there are two "channel test" relays for each combination of three paths (district link, office junctor, and office link). If either relay is operated, the particular combination of three cannot be used. In order to notify the marker if any one of the three paths is busy, the test lead for each path is connected to a different winding on the channel test relay. By means of these windings any path can indicate to the marker immediately whether it is busy or not, and if one of the three is busy, the marker can proceed to find the set of three idle paths which can be used for the call.

The originating marker is arranged to test a maximum of twenty channels simultaneously, each channel consisting of a district link, office junctor, and an office link. Where the number of district and office frames is ten, there will actually be twenty office junctors which can be used for a given call, although with other numbers of frames there may be either more or less than this number of office junctors available. The following discussion assumes ten district link and ten office link frames where twenty office junctors are actually available for use between a given district link frame and a given office link frame since the distribution for this combination of frames is the simplest.

Twenty district links appear on the verticals of the primary switch on which a calling district junctor is located. These twenty district links are distributed one from each half switch to the twenty secondary half switches on the district link frame. Since each of these district links (on a call to a particular office link frame) may be matched with an office junctor, there is one office junctor to the particular office link frame from each district link secondary half switch.

The outgoing trunk chosen by the marker to handle a call is located on a horizontal of a secondary switch on an office link frame. Twenty office links appear on the verticals of this secondary switch, one from each primary half switch. In order to match one office junctor with each of these twenty office links, one office junctor from the particular district frame terminates on a vertical of each primary half switch on the office link frame. Actually, each office junctor from a given secondary half switch on a particular district link frame terminates on a similarly numbered primary half switch on the office link frame.

The twenty district links from the primary switches on which the calling district junctor appears are numbered 0L, 1L, etc. to 9L and 0R, 1R, etc. to 9R in accordance with the vertical and primary half switch on which they appear. Each district link appears on a secondary half switch having the same number. The office junctors are similarly numbered in accordance with the district link secondary half switch and office link primary half switch on which they appear. The office link from an office link primary half switch (0L, 1L, and etc. to 9L and 0R, 1R and etc. to 9R) goes to a similarly numbered vertical on a secondary switch and each office link is, therefore, correspondingly numbered.

In matching the district links, office junctors, and office links, three paths having the same number are always used together on a call from a particular district to a particular office. An 0L district link, 0L office junctor, and 0L office link are always used together and are connected to the same channel test relay which also bears the number 0L. The 0L district link may, however, be used with some other office junctor on a call to another office frame and the 0L office link may be used with some other office junctor on a call from some other district frame.

The channel test relays are operated by any one of the three paths of a combination which may be busy. The originating marker tests for an idle channel in the twenty channels under test in order from lowest to highest. This results in the assignment of calls to lower numbered channels first and leaves the higher numbered channels available for calls in busy periods. This method of assigning calls is sometimes referred to as "packing" and is advantageous from a traffic and maintenance point of view. The assignment of calls proceeds in an orderly manner from the lower to the higher numbered channels. Leaving the higher numbered channels open reduces the blocking of calls and insures a call finding a combination of paths to the office frame required in all but the very busiest periods. To insure that the point of greatest wear may be varied during the life of the office, the point at which testing starts may be changed from the lowest to some other point in the chain at stated intervals.

The number of channels available for connecting a particular district junctor to a particular selected trunk depends upon the number of office link frames installed, as the office junctors of a particular district frame are equally distributed over the office frames. This number is reduced to one-half if the trunk level involved is "split", as in this case only the left or the right half of the links and junctors can be used, whereas for "nonsplit" trunk levels, both halves are available. In any case, not more than twenty channels are tested at one time.

With the sleeve leads of the available district links, office junctors, and office links connected, the decoder marker tests the channels and selects the first one encountered having all three of its parts idle. It then operates the district and office primary and secondary hold magnets for the selected channel, and releases the operated select magnets as the marker returns to normal.

The marker does not send a release signal to the sender until it has determined that an idle trunk is available. If a trunk group is divided into two subgroups (41 to 80 trunks), and all the trunks in the first subgroup are found busy, the second subgroup is tested. This subgroup may be a different pair of office link frames and may be a different trunk level. The marker is arranged, however, to select a trunk in one subgroup and on the next call to select a trunk in the other subgroup.

If a trunk group has 81 to 520 trunks it is subdivided into 3 to 13 subgroups. One of these subgroups will be a "common" subgroup while the others are "individual" subgroups. In this case, the marker is arranged to test one of the individual subgroups, alternating on successive calls, and if found busy, to test the common subgroup; thus, the marker will only test 80 trunks because it is assumed that if all the trunks in the common subgroup are busy, all of the individual subgroups' trunks are also busy.

Alternate routes through crossbar tandem or 2-wire office centers may be provided as an additional choice common to a number of original routes. If all the trunks of an original route are found busy and there is an alternate route, the alternate route relay is operated for testing these trunks. A second alternate route relay may be provided as described for an original route if there are three or more trunk subgroups. If all alternate route trunks are busy, or if all original route trunks are busy and there is no alternate route, the marker connects the district junctor to an overflow trunk which returns overflow tone to the calling subscriber.

If all the trunks' (both original and alternate, if there is an alternate) routes are busy, the call is routed to an overflow trunk; but if all the overflow trunks are busy, the marker will signal the sender through the district link, district junctor, and subscriber sender link crosspoints which are still closed. This signal will cause the sender to advance the district junctor circuit as if the call was being regularly advanced; no crosspoints will be closed on the district link frame. The subscriber, receiving no overflow signal and no audible ringing signal, will realize that there is something wrong and will, therefore, disconnect. The signal from the marker will also cause the sender to release.

If the marker is on a second trial, the sender will transmit its desire to route the call over the alternate route if there is one; otherwise, the marker will have to route the call again over the original route.

However, if the trunks in either the alternate route or the original route, as the case may be, and the overflow trunks are all busy, the marker will signal the sender as it did on a first trial.

If the marker is on a third trial, the sender will inform the marker to route the call to the overflow trunks only. If all the overflow trunks are busy, the marker will transmit a trouble release signal to the sender and the sender will function as described for first and second trial.

If all permanent signal trunks are busy on the first trial, the marker will call in the trouble indicator which will make a record of the call and then cause the sender to advance the district junctor as in a regular call. If trouble indicator is busy, the marker will not wait but will send the release signal in place of the trouble indicator. The district junctor will hold to the line in trouble until the trouble is cleared or the connection is released manually.

Since the marker can test a maximum of only 20 channels at a time, the marker may be required to test 100 channels (2 frame job). The marker then is arranged to test the first group of 20 channels; and if all channels in this subgroup are busy, the marker will make another test in the second subgroup, etc., until all channels in all subgroups (maximum of 5 subgroups) are tested.

The originating marker will be informed by the office link frame as to whether the trunk group selected is on a split or nonsplit level. This enables the marker to determine whether it should test and select one of 20 or 10 office junctors. If a split indication is received, the marker will test only 10 office junctors, those having access to the chosen trunk, the remaining 10 for the other half switches being made to appear busy by the marker.

When the trunk is selcted, it may be on the even or odd office frame. The office frame with its selected trunk will remain connected to the marker while the mate office frame will be released by the marker. The marker has only 20 leads for testing the links on only one office frame. Now, if the mate office frame were allowed to remain connected, the marker would be testing the links on both office frames, thus interfering with testing for an idle link.

The marker is arranged to reverse the order in which the trunks are tested if the call is on an odd numbered district link frame.

The marker is arranged to make a continuity check to the subscribers' message register. Failure to complete this continuity test will cause the call to be blocked.

If any of the leads to the sender of district junctor are open, shorted, or falsely grounded, or if there are double connections or false grounds on the channel selected, or in case some lead in the marker is shorted or open in a way to block the circuit functions, the marker seizes the originating trouble indicator to leave a record of the trouble. It then sends a trouble release signal to the sender so that the sender may release and make another attempt to complete the call.

In case an idle trunk is found but no channels to that trunk are available, the trunk group is tested again, the trunks on the frame which cannot be reached, however, being caused to appear busy. This is done in an attempt to find an idle trunk on the other office frame of the pair. If a trunk and channel are found in this way, the call proceeds as in regular operation. If no trunk can be found on this frame, or if there is an idle trunk but no channel to it, a trouble release signal is sent to the sender. Since a regular release signal has been already sent, and the selection register information in the sender has consequently been locked in, it is impossible in this case to progress to second choice or alternate route trunks on the same trial.

A trouble release signal may be sent to the sender either through the marker connector or through the district junctor and sender link after the marker connector is released. It may be sent by way of the district junctor and sender link if a trouble condition or a busy condition involving the marker functions occurs after the transmission of a regular release signal through the marker connector.

Reception of a trouble release signal, by the sender causes it to make a second or third trial regardless of a regular release signal which it may have already received.

On a second trial, trunk testing starts at the alternate route trunks, if there is an alternate route. It may progress to the second alternate route relay, if there is one, and then to the overflow trunks under busy conditions. If there is no alternate route, the original route trunks are tested as on a first trial, except that on any second trial, the order of testing the trunks is reversed.

On a third trial, the overflow trunks alone are tested. If all channels are busy, then a trouble release is again sent to the sender causing it to restore to normal.

The functions or general operations just described for the originating marker are divided into two general classes, namely, "decoder stage" and "marker stage." The decoder stage takes place and the marker starts the marker stage up to the point where a trunk to the desired office has been selected. The marker then sends a release signal to the sender which in turn releases the marker connector circuit. Another marker connector may now choose this marker to handle a different call although the first call is still in the marker stage. This "overlap" is permitted in order to reduce the marker holding time.

DISTRICT LINK FRAME

PURPOSE

The purpose of the district link frame is to interconnect district junctors with office junctors under control of the originating marker. It is always used in conjunction with its associated district junctor and subscriber sender link frames as illustrated in Chapter 1.

DESCRIPTION - RM 5-4, RM 314

The district link frame provides a location for the crossbar switches used to increase to a practical number the paths over which the chosen district junctor may reach the office frame, on which the outgoing trunks to the desired destination are located, and for the equipment required to connect the test leads of the various paths through the frame to the originating marker so that the marker may test and select a path to the correct office frame.

The frame is a single-sided, two-bay structure. The left or primary bay mounts ten 200-point, 3-wire crossbar switches. Each of the ten horizontal levels of each switch are multipled across the twenty verticals and are connected to a district junctor. Thus, there are 100 district junctors on the horizontals of the ten primary switches. The verticals of each primary switch number 0 to 9 left and 0 to 9 right.

Located at the top of the primary and secondary bays are multicontact relays called connector relays used to enable the marker to test the district links and office junctors prior to selection.

The right or secondary bay mounts ten 200-point, 3-wire crossbar switches. Each switch has ten left verticals (0 to 9) and ten right verticals (0 to 9) which are connected by means of office junctors to the office link frames through the office junctor grouping frame as will be explained later.

The district link frame link spread as shown in Fig. 2A is from vertical to horizontal. Since we are using 200-point primary switches, we have 200 verticals to be connected to the 100 secondary horizontals, making it necessary to use split horizontals by omitting the strap between the right and left halves of the secondary switches.

In the distribution of district links from the primary switches, each primary switch is treated as though it were two half switches, a left half and a right half. Each primary left half switch has one district link to each of the ten secondary left half switches and each right half primary switch one to each of the ten secondary right half switches. Since a district link appears on a vertical of a primary half switch and on a horizontal of a secondary half switch, any link may be traced in accordance with the following formula. The primary vertical is the same as the secondary half switch on which it appears and the primary switch is the same as the secondary horizontal.

The arrangement of district links just described provides a symmetrical distribution of the 200 links from the primary switches to the secondary half switches. This symmetry of distribution simplifies wiring and maintenance tracing of paths and is satisfactory from a traffic point of view.

Two hundred office junctors are outgoing from the secondary switches of the district link frame. These junctors are divided into groups of equal size, one group to each office frame and are matched with the 200 district links as required to set up combinations of paths between district junctors and outgoing trunks.

The connector circuit of the district link frame consists of marker connector, link connectors, and junctor connector relays. The marker connector relays consist of 1-1/2 multicontact relays per marker which are for the purpose of connecting the test leads of district links and office junctors to the marker, together with the operating leads for the various crossbar switches. The link connector circuit consists of ten multicontact relays, each of which connects the test leads of twenty district links (from a particular primary switch) to the particular marker connector relay for connection to the marker. The junctor connector circuit consists of twenty multicontact relays, each of which controls the test leads for a maximum of twenty office junctors. The operation of one of these relays connects the test leads of a maximum of twenty office junctors to the marker connector relay being used for setting up the call.

Since the number of office junctors from each district link frame to a particular office link frame depends on the total number of office link frames, the number of junctors to each office link frame varies from ten, in the case of twenty office frames, to 100 when there are only two office frames. Since the marker tests office junctors in groups of twenty, there may be a number of junctor connector relays associated with the group of office junctors to a given office link frame when there are less than 10 frames. For this reason, the various junctor relays associated with the group to a given office frame may be used alternately to connect first, second, third, fourth, and even fifth subgroups of test leads to the marker.

The assignment of the junctor sleeve leads to the junctor connector relays depends on the distribution pattern used for distributing the office junctors from district link to office link frames. Since this distribution will be discussed later, the method of assigning office junctor sleeve leads to the junctor connector relays on the district link frame will also be discussed later.

There is a set of marker connector relays for each originating marker having access to a particular district link frame. The test leads from each set of multicontact relays are carried to the particular marker in switchboard cable and are also multipled to the corresponding multicontact relay on other district link frames. In order to safeguard this multiple in case of damage to a particular district link frame, the even numbered markers are cabled to the lowest numbered district link frame and multipled to all higher numbered frames. The odd numbered markers are cabled to the highest numbered district link frame and multipled to all lower numbered frames.

FUNCTIONS

The district link circuit permits one marker at a time to establish a connection between the district junctors in its associated district junctor frame through office junctors to any office frame. It starts to function upon receipt of a signal from the seized office link frame via the originating marker. The marker connector relays then operate to connect the district link circuit to the originating marker.

The district link circuit grounds a lead through the marker connector relays to the marker, and thence through the marker connector circuit, subscriber sender, subscriber sender link, and district junctor, where it operates a relay which extends it to the district link circuit where it operates the proper link connector relay. Up to this time, the only information that the originating marker had in regard to the district junctor being used was the district frame number; thus, it might be any one of the 100 district junctors. The link connector relay associated with the primary switch which contains the chosen district junctor will now close through to the marker the link sleeves or primary hold magnets so that the marker may test and select one.

The relay which we operated in the district junctor on the above path causes the primary select magnet to operate in preparation for closure of the crosspoint by the marker after its selection is completed.

The district link circuit operates the ten secondary select magnets associated with the 20 links under test, and in conjuntion with the district junctor it closes leads from the marker to the district junctor relays so that the marker may control the proper setting for talking and charging.

The district link circuit allows the marker to select which group of secondary holding magnets or office junctors it desires.

After the marker has matched up a district link, an office junctor and a path through the office link frame to the chosen trunk, it proceeds to close the crosspoints completing the talking circuit. The marker will place the connection under control of the district junctor circuit and then cause the release of the various connectors and restore to normal.

If trouble exists in the district link circuit which would prevent its seizure by a marker, the district link circuit is arranged to automatically substitute the emergency marker preference relays.

Upon signal from the marker, the district link circuit will give a visual and audible alarm in case all permanent signal holding trunks are busy and another call is seeking one of these trunks.

OFFICE LINK FRAME - RM 5-5, RM 312, RM 313

PURPOSE

The office link frame provides a location for the crossbar switches used to increase trunking facilities between the district link frame and the outgoing trunks. It also provides a location for multicontact relays which enable the marker to test the outgoing trunks and the office link frame links having access to the selected trunk.

DESCRIPTION

In order to insure uninterrupted service in case of a frame failure, the outgoing trunks of a trunk group to a specific office are divided between a pair of office link frames; thus, these frames are always furnished and operated in pairs.

The office link frame is a single-sided structure composed of two bays, primary and secondary. The left or primary bay contains ten 200-point, 3-wire crossbar switches and the necessary marker connector multicontact relays required to connect from 3 to 8 markers to the office link frame. The right or secondary bay contains ten 200-point, 4-wire crossbar switches and the necessary link connector and trunk connector relays.

The office junctors from the district link frames through the office junctor grouping frame terminate on the 200 verticals of the primary switches which have their horizontal multiples split at the midpoint to provide a group of ten horizontals on the left half and another group of ten on the right half of each switch.

The primary to secondary spread of the office link is from 200 horizontals of the primary switches (created by split) to the 200 verticals of the secondary switches. These 200 office links are divided from the standpoint of distribution into two similar groups of 100, one group interconnecting the left halves and one the right halves of the primary secondary switches. The 0 to 9 horizontals of each left primary half switch are connected, in the 0 to 9 left secondary half switches, to the vertical corresponding in number to the primary switch. The right links are similarly wired.

RM 313 also shows the switches associated with an office extension frame (formerly called office buildout frame) which is generally located adjacent and to the right of the office link frame although it may be located elsewhere. Traffic conditions determine the number of office link frames and whether or not the extension frames are required. In general, the office extension frame is used in offices where the traffic density is such that only 100 trunks (horizontals of secondary switches not split) can be assigned to each office link frame. A greater number of office links may be made available to a particular outgoing trunk by the use of these extension switches. Extension frames will normally be required on installations utilizing 12 or more office link frames.

The horizontals of the secondary switches are connected to the MDF for connection to the outgoing trunks. The horizontal strapping may or may not be cut on the secondary switches. If cut, the capacity of the frame is 200 outgoing trunks; but, if not, the capacity is only 100 outgoing trunks. Intermediate capacities of 120, 140, 160, or 180 outgoing trunks may be obtained by splitting 0 and 1, 0 to 3, 0 to 5, or 0 to 7 horizontal levels of each switch of the pair of office link frames.

The secondary switches employ all 4-wire switches in order to care for flexibility in the assignment of miscellaneous trunks such as special service and recording completing trunks, where a fourth wire is required for control purposes.

The secondary horizontals on the office extension frames are never split, and they employ only 3-wire switches in this area.

Outgoing trunks may work in common with panel or other crossbar systems, but they do not multiple to any other office link frame within the same installation.

The originating marker tests the outgoing trunks through the trunk connector relays located at the top of the secondary bay. The five pairs of multicontact relays on the left are always furnished. On the regular frame, they are designated TL0 (trunk left, level 0), and TR1 (trunk right, level 1), etc., to TL8 and TR9. On the extension frame, they are designated TL10 and TR10 to TL14 and TR14, TL10 and TR10 being associated with levels 0 and 1 and TL14 and TR14 with levels 8 and 9. Each of these 30 relays connects its corresponding level of each switch to the marker; for example, the TL8 relay will close the 10 trunks connected to level 8 on switches 0 to 9 to the marker for test.

An additional pair of trunk connector relays must be added for each pair of levels split on the secondary horizontals. These are designated TL1 and TR0, etc., to connect to the other half of the horizontals which were split.

The 10-link connector (LC) relays are used to connect the 200 office links to the marker for testing purposes. Each (LC) relay connects the 20 links associated with its corresponding numbered secondary switch.

The number of office link frames required depends on the number of trunks necessary to handle the volume of outgoing traffic. Usually there are as many or more office frames as district frames since the office frames are always furnished in pairs, as 4 district link frames will require 4 office frames. The size of the crossbar office is referred to as a 2, 4, 6, 8, 10, etc., up to 20 frame job, a full size installation.

ASSIGNMENT OF OUTGOING TRUNKS - OS 329, RM 315

The capacity of an office link frame is 100 outgoing trunks if the secondary horizontals are nonsplit, and 120 to 200 outgoing trunks in increments of 20 depending upon the number of horizontals split.

The originating marker is arranged to make a simultaneous test of a maximum of 40 outgoing trunks in an attempt to locate an idle one. A group to a given destination containing more than 40 trunks is subgrouped into test groups (forty trunks). The 40 trunks of a test group are distributed over the secondary switches of the two office link frames of a pair. A feature of the marker permits trunks to more than one destination to be placed in the same test group. On a given call, all trunks of this test group to other than the desired destination are disregarded. A test group normally includes all of the trunks to a given destination which are assigned to one pair of office link frames, although trunks to a given destination may be assigned to more than one test group on more than one pair of office link frames.

OS 329 shows the method of assigning the outgoing trunks to test groups. The 40 trunks are spread over the twenty secondary switches of the two office link frames, two per switch in order to insure uninterrupted service in case of frame or switch trouble. The first 20 trunks are spread in such a way that only one trunk appears on a level of each secondary switch alternating between the even and the odd office frames. The remaining 20 trunks of the test group are assigned in a similar manner using another level on each switch. The reason for assigning trunks 0 to 19, one per switch, and then 20 to 39, one per switch, rather than two per switch is to prevent small trunk groups from being concentrated into a few switches. From the above, we see that a trunk test group requires two horizontals, or "trunk levels" per switch. When the horizontal multiple is split, the other half of each level is assigned to another test group.

Since two office link frames are involved, an even number of horizontal levels must be used. The size of a trunk group within a test group may vary from a minimum of 2 to a maximum of 40 trunks. If the trunk group contains an odd number of trunks, the unused trunk level must be made to test busy.

The horizontals on office link extension frames are never split. Trunks are assigned to the pair of office extension frames and are tested in the same manner as described for nonsplit secondary switches on regular office frames.

The originating marker has access to the extension frame through the office link extension (TL) and (TR) relays numbered 10, 11, 12, 13, and 14 that are wired to operate as follows:

Originating Marker		Office Link Extension
TL10	operates	TL10 and TR10
TL11	"	TL11 and TR11
TL12	"	TL12 and TR12
TL13	"	TL13 and TR13
TL14	"	TL14 and TR14

The numbers assigned to the outgoing trunks indicate the order of their presentation to the marker for testing. The first test group is connected through the trunk connector relays (TL0) and (TR1) of both frames. Tracing the assignment for the various trunks of the test group, the order of assignment is as follows:

EVEN FRAME

	Even Numbered Trunks										Reg. Frame Conn. Relay	O.E. Frame Conn. Relay
Trunk	0	2	4	6	8	10	12	14	16	18		
Switch	0L	1R	2L	3R	4L	5R	6L	7R	8L	9R	TL0	TL10
Level	0	1	0	1	0	1	0	1	0	1		
											and	and
Trunk	20	22	24	26	28	30	32	34	36	38		
Switch	0R	1L	2R	3L	4R	5L	6R	7L	8R	9L	TR1	TR10
Level	1	0	1	0	1	0	1	0	1	0		

ODD FRAME

Odd Numbered Trunks

											Reg. Frame Conn. Relay	O.E. Frame Conn. Relay
Trunk	1	3	5	7	9	11	13	15	17	19		
Switch	0L	1R	2L	3R	4L	5R	6L	7R	8L	9R	TL0	TL10
Level	0	1	0	1	0	1	0	1	0	1		
											and	and
Trunk	21	23	25	27	29	31	33	35	37	39		
Switch	0R	1L	2R	3L	4R	5L	6R	7L	8R	9L	TR1	TR10
Level	1	0	1	0	1	0	1	0	1	0		

The reference to "left" and "right" switches has little significance in the nonsplit case, since the strapping on each horizontal is continuous.

The second test group of trunks becomes available when, to continue with the foregoing example, levels 0 and 1 are split. For thest trunks, secondary switch connector relays TL1 and TR0 are used.

Since one set of connections toward the markers is common to all TL relays on the frame and one set to all TR relays, the (TL1) and (TR0) relays must connect their trunks to these common leads in the same order as the (TL0) and (TR1) relays. The order of assignment of these trunks must consequently be as follows:

EVEN FRAME

Even Numbered Trunks

											Conn. Relay
Trunk	0	2	4	6	8	10	12	14	16	18	
Switch	0L	1R	2L	3R	4L	5R	6L	7R	8L	9R	TL1
Level	1	0	1	0	1	0	1	0	1	0	
											and
Trunk	20	22	24	26	28	30	32	34	36	38	
Switch	0R	1L	2R	3L	4R	5L	6R	7L	8R	9L	TR0
Level	0	1	0	1	0	1	0	1	0	1	

ODD FRAME

Odd Numbered Trunks

											Conn. Relay
Trunk	1	3	5	7	9	11	13	15	17	19	
Switch	0L	1R	2L	3R	4L	5R	6L	7R	8L	9R	TL1
Level	1	0	1	0	1	0	1	0	1	0	
											and
Trunk	21	23	25	27	29	31	33	35	37	39	
Switch	0R	1L	2R	3L	4R	5L	6R	7L	8R	9L	TR0
Level	0	1	0	1	0	1	0	1	0	1	

From the above charts you will note that the trunks are assigned in a defite sequence as follows:

(a) They alternate between the even and odd frames on the pair of office frames.

(b) On the same frame, they progress over all switches in order, making two cycles, one for each of the two levels required.

(c) On the same frame, they alternate between left and right half switches as they progress from switch to switch.

(d) On the same frame, they alternate between the two levels required, starting with the even level for the first test group and with the odd level for the second test group (if levels are split).

When split horizontals are used on the secondary switches, the number of office links having access to a given outgoing trunk is cut in half and the number of paths between the selected district junctor and the selected trunk is correspondingly decreased. Where the number of office junctors per district per office is less than 20 (more than 10 frames) this becomes severe. In general, therefore, split secondary horizontals will not be employed for more than ten frames.

FUNCTIONS

The function of the office link frame is to interconnect office junctors with outgoing trunks under control of the originating marker.

Only one originating marker is permitted to connect to the pair of office link frames on which the desired trunk group is located. Thus, only one call is handled at a time by one pair of office link frames. The marker selects the proper pair of office link frames. It then directs the office link frame to cut through the desired trunk test group sleeve so that the marker may select an idle trunk. The office link frame signals the marker as to whether the selected trunk group has split or nonsplit horizontals. The marker then selects an idle trunk in this group and from the number (marker number 0 to 39) of the trunk selected the marker recognizes the particular frame of the pair, the particular secondary switch and the particular level on that switch. The marker will then operate the primary and secondary select magnets in preparation to closing the crosspoints. The proper link connector relays are operated to close the office link frame links (10 left and 10 right) having access to the chosen trunk through to the marker for test and selection.

With the district link frame and the outgoing trunk selected, the marker then proceeds to select a "channel" or path between the district junctor and the outgoing trunk. When this is done, the marker operates the primary and secondary hold magnets which close the crosspoints and complete the talking circuit to the outgoing trunk. The hold magnets are put under control of the district junctor and the marker and various connector circuits then release from the connection.

If the office link connector circuit is busy, the marker will wait until it is idle and if two or more markers are waiting, they will be served in a definite order.

Under normal operation, the marker places its call at one of the two office link frames. In the event of a trouble condition, the leads used for calling in the office link connector are automatically transferred to the connector on the mate frame. Visual and audible signals are operated to indicate that trouble occurred and are released by the operation of a key.

The circuit is arranged to make any one or more switches appear busy, or to make the whole frame appear busy. In this case, all calls will be served by the mate frame.

OFFICE JUNCTOR DISTRIBUTION, RM 318, 319, 320

A calling line may be connected to any one district junctor circuit on any one of five different district junctor frames (depending on district junctor distribution), and that district junctor may be on any horizontal of its associated district link primary switch, and the call may be originated to any office in the dialing area. The outgoing trunks to the called office may be located on any pair of office link frames; thus, in order to allow all subscribers to originate calls to any office, it is necessary to provide paths (office junctors) from each district link frame to each office link frame.

Since there are 200 office junctors connected to the verticals of a district link secondary switch, and these must be distributed to each office link frame, the number of office junctors to be connected to a particular office link frame can be determined by dividing the 200 office junctors by the number of office link frames. As the number of office frames varies from 2 to 20, the number of office junctors per district frame per office frame will vary from 100 to 10.

The distribution of district links and office links between primary and secondary switches on their respective frames follows a definite pattern which does not vary from one frame to the next; and the wiring for this distribution can, therefore, be included in a frame local cable in a uniform manner for all district frames and for all office frames.

The distribution of office junctors is more complex, in that the number of junctors from a given district to a given office frame varies with the number of frames.

The general problem, then, is to arrange the distribution of office junctors in such a manner that calls will proceed with a minimum of blocking and at the same time permit the number of office frames to grow (and the number of office junctors per district per office to decrease) with a minimum of wiring changes.

OFFICE JUNCTOR GROUPING FRAME - RM 5-6, RM 321

The function of the office junctor grouping frame is to provide means for terminating the office junctors between district and office link frames so that each group of 100 district junctors will have equal access to the outgoing trunks on each office frame.

In addition to providing means of access, this grouping frame is arranged so that as the size of the office increases, the effort required to change the junctor distribution is kept to a minimum without affecting service due to taking out of service too much equipment during the change.

The office junctor grouping frame consists of 10 vertical rows and ten horizontal rows of terminal strip blocks mounted so that one end of the terminal strip lugs are toward the front of the frame, and the other toward the rear of the frame.

Switchboard cables containing the office junctors from the district link frames are run vertically (2 district frames per vertical) and connected to the terminal strip lugs on the front of the frame.

Switchboard cables containing office junctors going to the office link frames are run horizontally (2 office frames per block) and connected to the opposite ends of the terminal strip lugs on the rear of the frame. Thus, a cable from an office link frame crosses the cables from all district frames, and vice versa. At the terminal blocks where the cables cross, the leads of the ten paths (one vertical of a half switch) between the particular district and office frames are connected to the terminal strip lugs, the district on one side and the office on the other forming permanent connections between these frames.

If the capacity of the office is furnished, that is 20 district frames and 20 office frames, cables would be connected to both sides of all the terminal blocks making all connections permanent. However, if less than this number is furnished, only a part of the terminal blocks will have cables connected to both sides. Those having cables to the district side only will have cross connections made to those having cables on the office side, only in accordance with a standard chart for that particular size of installation.

When an addition of district or office link frames is made, additional cable is run increasing the number of permanent connections and thus only requiring the removal of a few cross-connections.

Below the terminal strip blocks mentioned above, there are terminal strip blocks mounted horizontally which are used for the distribution of battery leads to the office primary hold magnets, from the fuse associated with the corresponding district secondary holding magnets. This eliminates parallel fusing, as both holding magnets are operated in parallel.

As an example of the office junctor distribution, let us assume an office has ten district frames and ten office frames. We can now find out how many office junctors per district per office frame we can have. The 200 office junctors (per district) divided by 10 (number of office frames) which gives us 20 office junctors, one from each district link secondary half switch to a correspondingly numbered primary half switch on each office link frame. Fig. 8 shows the 20 office junctors between district link frame 2 and office link frame 7 for this 10-10 job. On this sketch, the twenty possible paths or "channels" between the calling district junctor and the outgoing trunk may be traced. The distribution of the 20 junctors between this district frame or other district frames to other office frames is similar.

To continue with the above example, let us assume that we now have 20 district and 20 office link frames. The number of office junctors per district per office has now decreased to 10. These 10 are scattered over the twenty half switches available in accordance with a definite pattern which provides a minimum of blocking. These ten are represented in Fig. 8 by the solid line at the office junctor grouping frame to indicate these are the junctors permanently connected. The dotted line shows the junctors that are temporarily cross connected in the above 10-10 case, pending growth of the office.

ASSIGNMENT OF JC RELAYS - OS 334, RM 317

We obtain the number of office junctors per district per office frame by dividing the 200 office junctors leaving any district link frame by the number of office link frames so that an even number (insofar as possible) of office junctors extend to each office frame. As the number of office frames varies from 2 to 20, the number of office junctors per district per office will vary from 100 to 10 as shown in the following table:

No. of Office Frames	No. of Junctors Per Dist. Per Office	No. of Dist. Link JC Relays Required
2	100	10
4	50	10
6	33 or 34	10
8	25	10
10	20	10
12	16 or 17	12
14	14 or 15	14
16	12 or 13	16
18	11 or 12	18
20	10	20

The table shows the number of (JC) junctor connector relays that are required on each district link frame to enable the marker to test these junctors. Each (JC) relay is capable of connecting 20 office junctor sleeve leads (through the marker connector relays) to the marker which is arranged always to test a group of 20 office junctors simultaneously. The following examples, together with RM 317, show the method in which this relay is employed.

On a 10 office frame job, as noted from the table on the previous page, 10 (JC) relays are employed, each relay cuts through a test group of 20 office junctors from the chosen office link frame to the marker.

On the 2 office frame job, 5 (JC) relays cut through one group of 100 junctors to one office frame, and the remaining 5 (JC) relays cut through the second group of 100 office junctors to the other office frame. The marker in this case will operate one of the (JC) relays and test that subgroup of 20 and, not finding an idle office junctor, it will release that (JC) relay and operate another, etc. In this manner, the marker may make five separate tests in order to test the complete group of 100 office junctors.

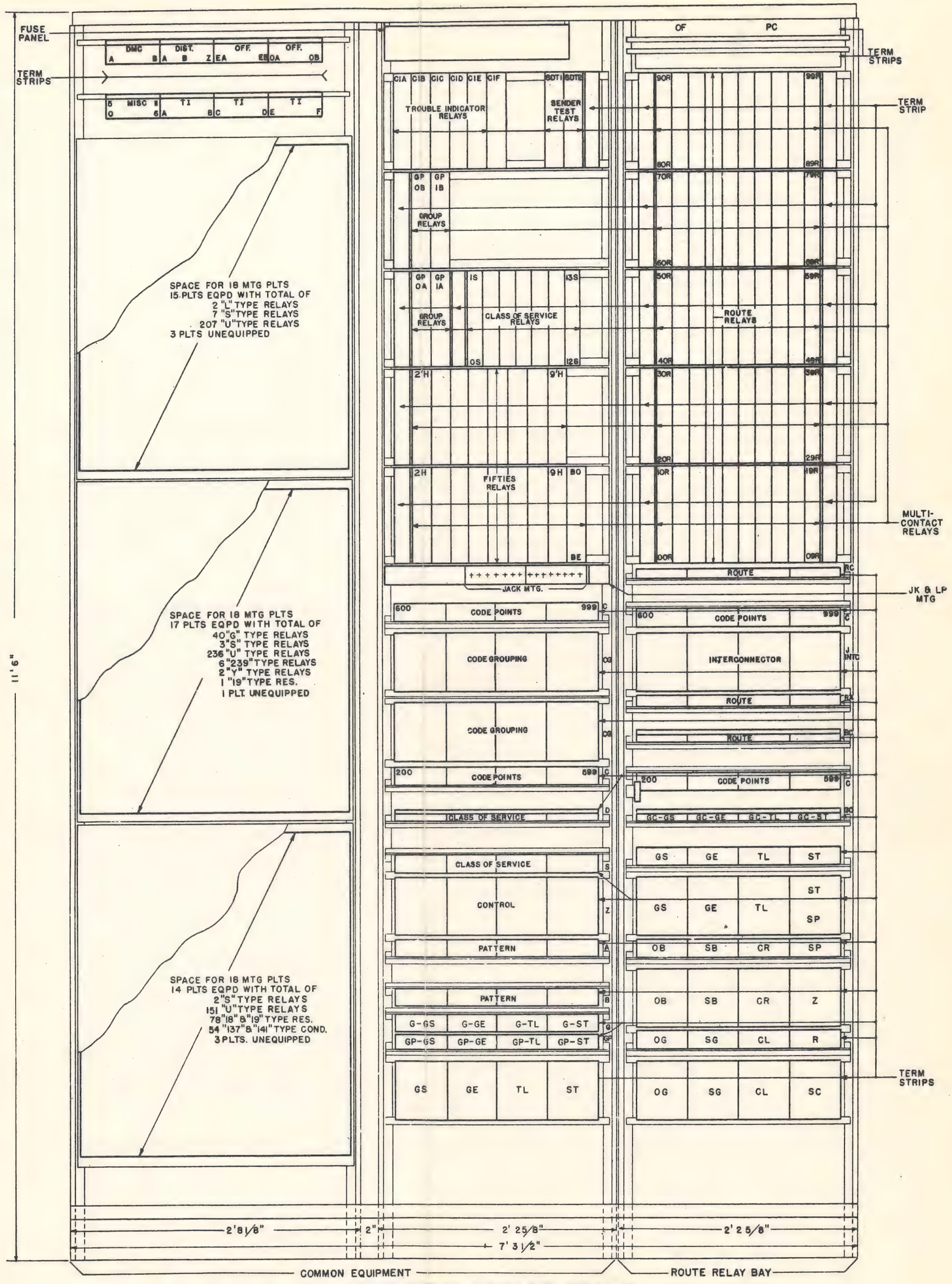
On the 8 frame job, 2 (JC) relays cut through a group of 25 office junctors. One (JC) relay cuts through 20 of the 25 to the marker for test and the second (JC) relay cuts through the remaining 5. This second (JC) relay is also used to cut through the remaining 5 office junctors of 3 other subgroups. The marker tests these leads in groups of twenty, however, and the junctors not available to the particular subgroup are made to test busy by "pattern" relays in the markers.

In the above cases, it will be noted that each junctor connector relay on the district link frame provides access to 20 junctors, and all terminals of each junctor connector relay are assigned to usable paths.

On the 12 frame and larger jobs, the office junctor group contains less than 20 office junctors. As described in the 8 frame job, the marker tests 20 junctors simultaneously and, therefore, the remaining test leads without junctors must be made to appear busy to the marker.

As seen from the table on the preceding page, on 10 or less frame jobs, the 200 office junctors on the district link frame require only 10 (JC) relays. During the period of growth to a full size job, the 200 office junctors on the district link frame will require from 12 to 20 (JC) relays. Thus, ultimately 100 of the 200 office junctors must be removed from the initially installed 10 (JC) relays and placed on the additional 10 (JC) relays. It is apparent, therefore, that the remaining 100 junctors on the first ten (JC) relays will never be disturbed regardless of the size of the installation. The test leads for these 100 "fixed" junctors are wired permanently to the contacts of the junctor connector relays from the switches, as shown in Fig. 10 by the heavy lines.

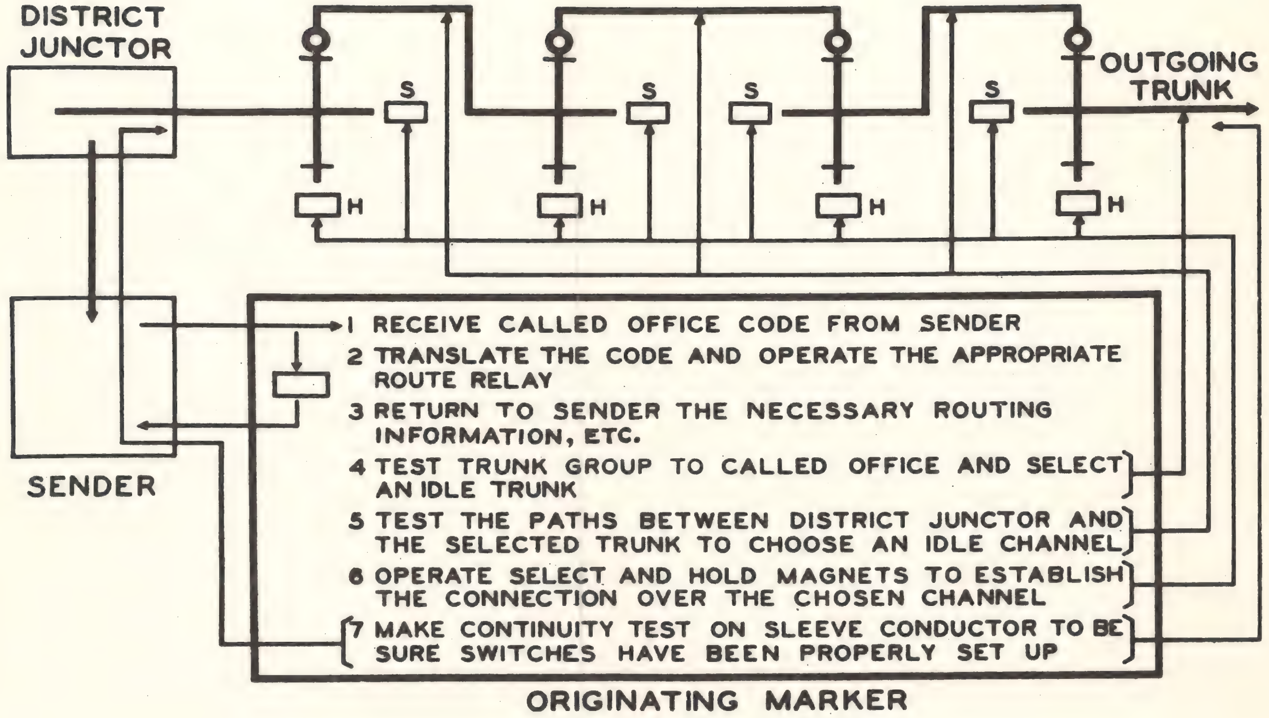
In order to facilitate changes necessitated by the growth of an office, the 100 "variable" junctors and their possible terminations on the (JC) junctor connector relays are wired separately to a secondary hold cross-connection block (SHX) where they may be cross connected in accordance with standard patterns to provide the required number of office junctors per group.



TS-603308

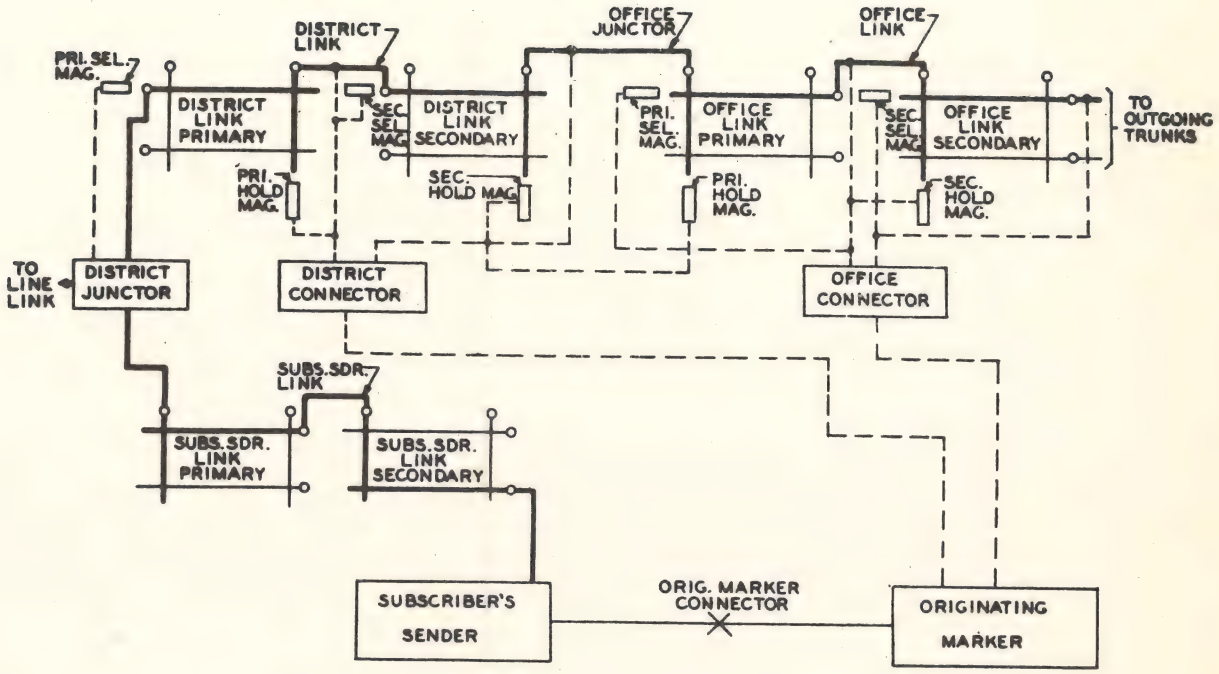
NOTE: AMOUNT OF VARIOUS RELAY EQUIPMENT WILL VARY ON DIFFERENT JOBS

ORIGINATING MARKER FRAME

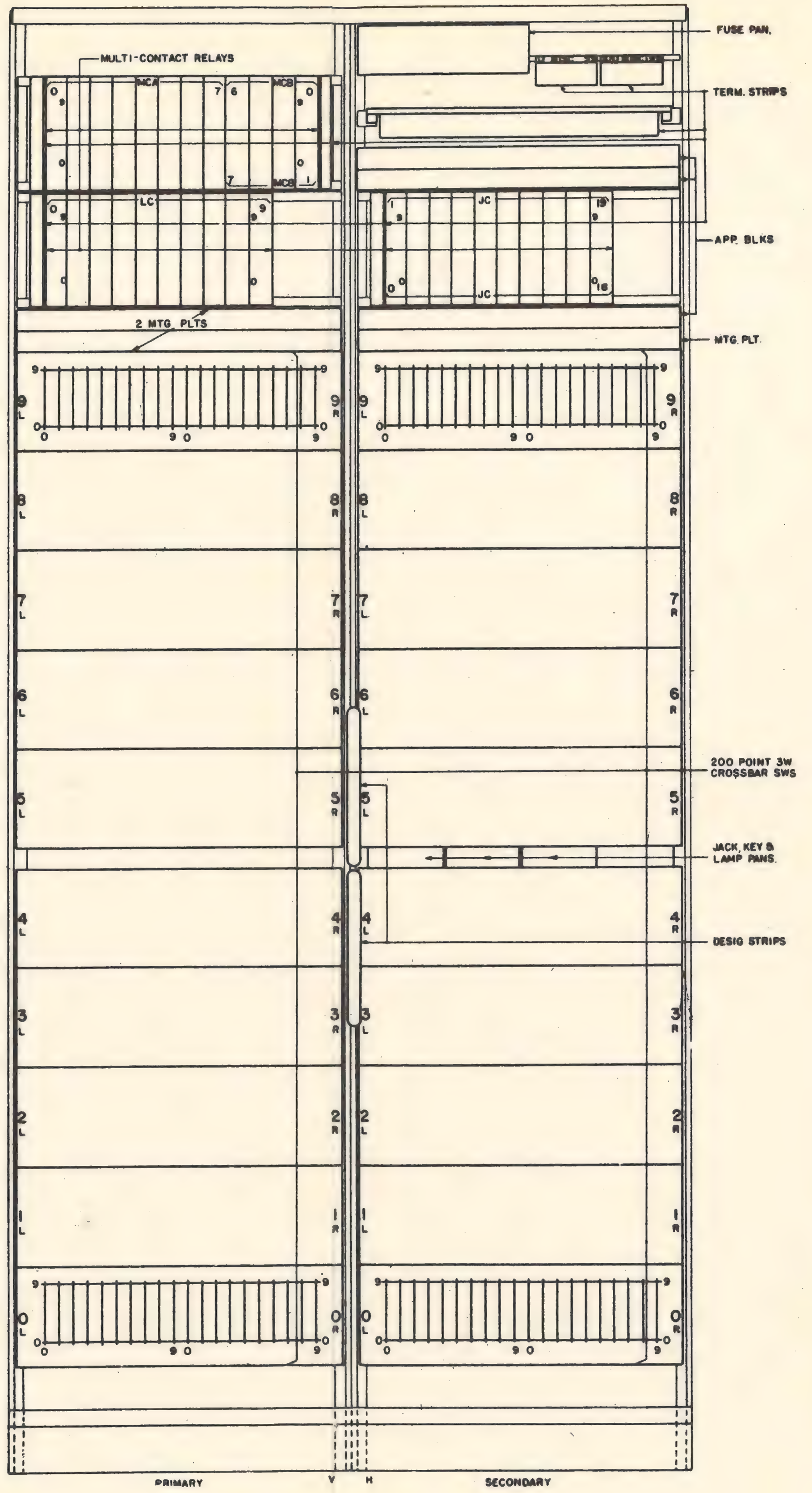


1 RECEIVE CALLED OFFICE CODE FROM SENDER
2 TRANSLATE THE CODE AND OPERATE THE APPROPRIATE ROUTE RELAY
3 RETURN TO SENDER THE NECESSARY ROUTING INFORMATION, ETC.
4 TEST TRUNK GROUP TO CALLED OFFICE AND SELECT AN IDLE TRUNK
5 TEST THE PATHS BETWEEN DISTRICT JUNCTOR AND THE SELECTED TRUNK TO CHOOSE AN IDLE CHANNEL
6 OPERATE SELECT AND HOLD MAGNETS TO ESTABLISH THE CONNECTION OVER THE CHOSEN CHANNEL
7 MAKE CONTINUITY TEST ON SLEEVE CONDUCTOR TO BE SURE SWITCHES HAVE BEEN PROPERLY SET UP

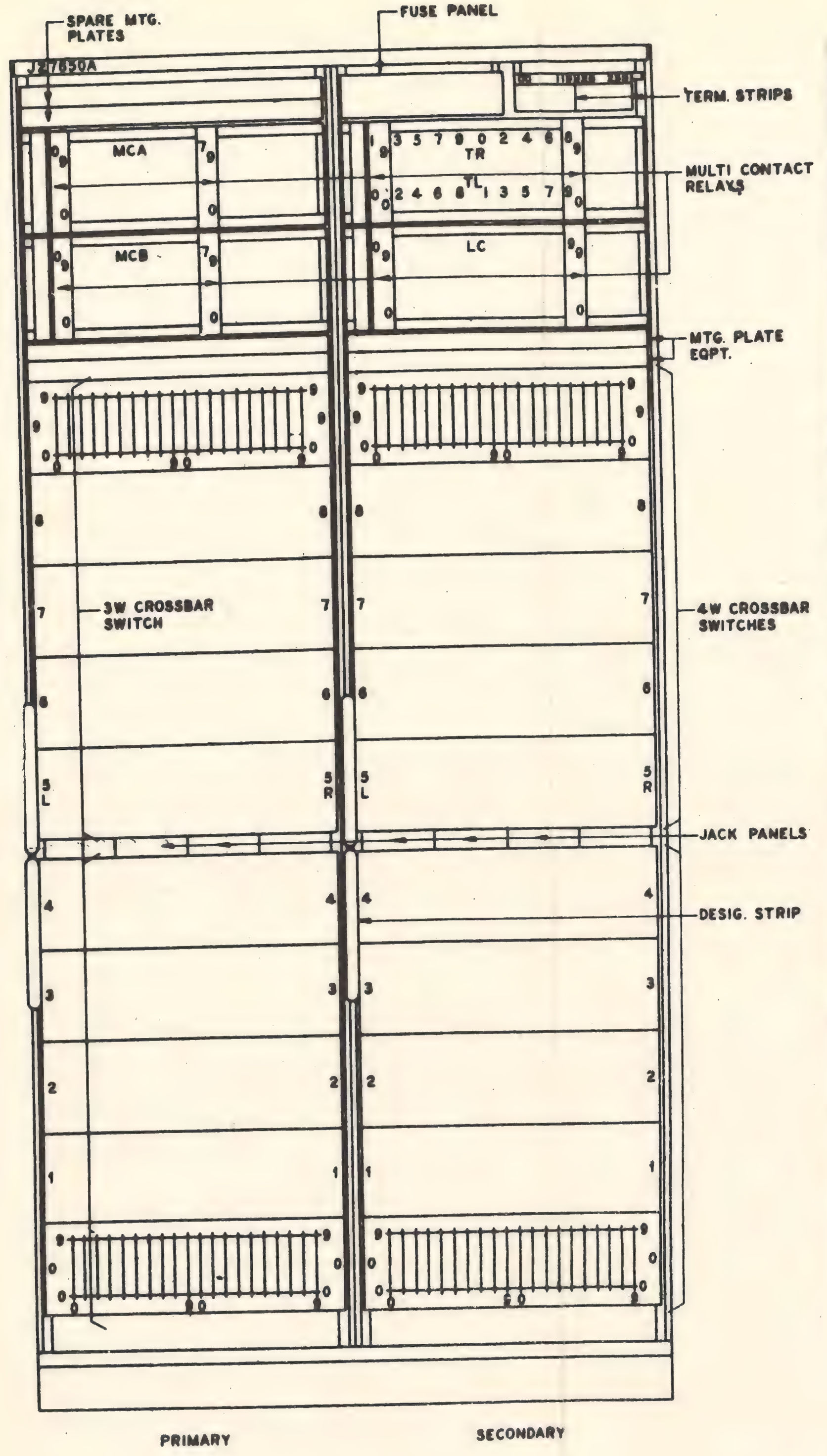
OPERATION OF ORIGINATING MARKER



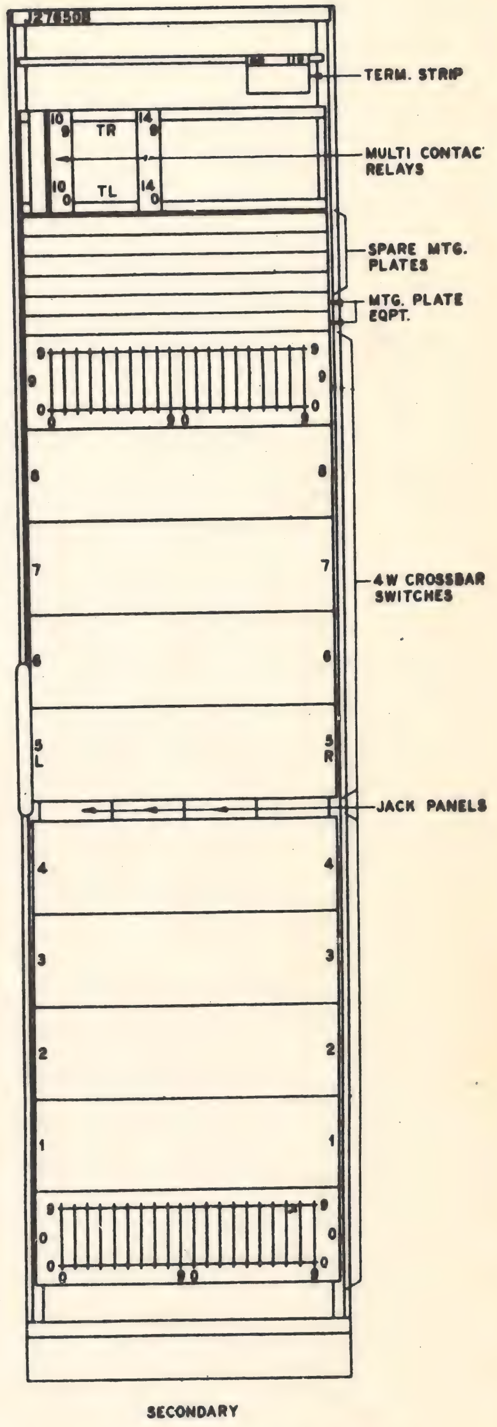
Connection of District Junctor
To Outgoing Trunk



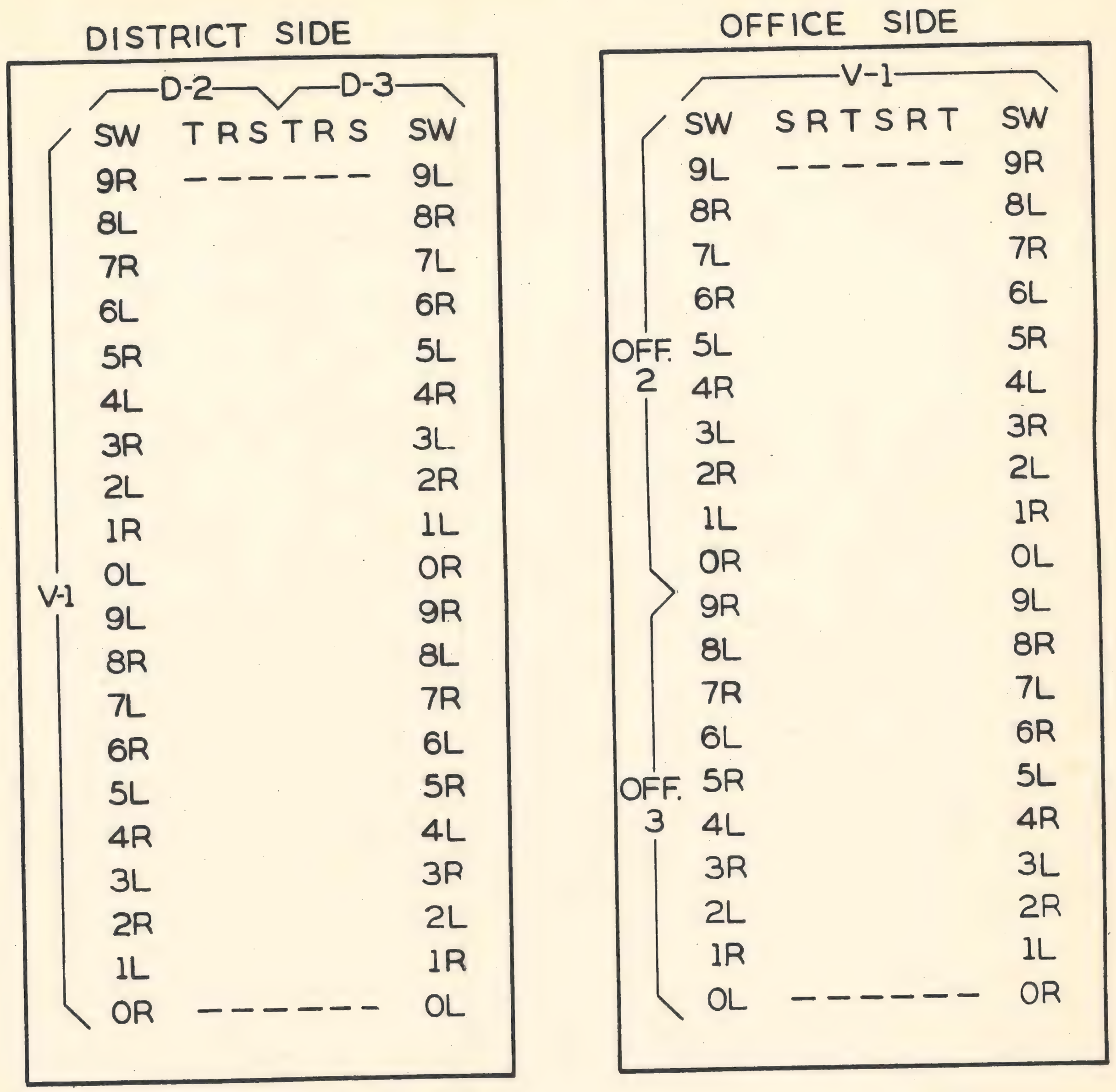
Districk Link Frame



Office Link Frame



Office Extension Frame



DISTRICT SIDE

		D-2			D-3			
	SW	T	R	S	T	R	S	SW
V-1	9R	-	-	-	-	-	-	9L
	8L							8R
	7R							7L
	6L							6R
	5R							5L
	4L							4R
	3R							3L
	2L							2R
	1R							1L
	0L							0R
	9L							9R
	8R							8L
	7L							7R
	6R							6L
	5L							5R
	4R							4L
	3L							3R
	2R							2L
	1L							1R
	0R	-	-	-	-	-	-	0L

OFFICE SIDE

		V-1						
	SW	S	R	T	S	R	T	SW
OFF. 2	9L	-	-	-	-	-	-	9R
	8R							8L
	7L							7R
	6R							6L
	5L							5R
	4R							4L
	3L							3R
	2R							2L
	1L							1R
	0R							0L
OFF. 3	9R							9L
	8L							8R
	7R							7L
	6L							6R
	5R							5L
	4L							4R
	3R							3L
	2L							2R
	1R							1L
	0L	-	-	-	-	-	-	0R

THE ABOVE REPRESENTS BOTH SIDES OF BLOCK MARKED WITH AN ASTERISK IN THE PRECEDING DIAGRAM. IT IS TYPICAL OF EVERY BLOCK ON THE FRAME EXCEPT FOR THE CHANGING OF DISTRICT FRAME, OFFICE FRAME AND VERTICAL NUMBERS.

OPPOSITE SIDES OF SAME BLOCK
ON
OFFICE JUNCTOR GROUPING FRAME

CHAPTER 5

SECTION 2

METHOD OF OPERATION

Originating Marker Circuit SD-25016-01

MARCH 1954

DECODING THE OFFICE CODE - FIRST TRIAL

SC 301, 302

SEIZURE OF MARKER - OS 301

A connector circuit upon seizing an originating marker through the operation of its DS and DMA relays causes the DA1 and DA2 relays to release, grounds the TM lead and operates the CBR, CBS and CBT relays.

The CBR, CBS and CBT relays receive their operating battery over the B lead from the miscellaneous circuit for the originating marker trouble indicator.

The marker will now test busy at all points at which it can be selected.

RECEIVING INFORMATION FROM SENDER - OS 305

When the connector circuit operates its multicontact relays, the receiving leads between the sender and the marker are closed, causing all the marker recording relays to operate.

The marker recording relays consist of relays A1, 2, 4 and 5, ~~B1, 2, 4, 5 and 5'~~ and C1, 2, 4 and 5, used to record the A, ~~B~~ and C digits respectively, relays D1, 2, 4 and 8, for recording the class of service of the calling subscriber, relays F1, 2, 4, 5, 10 and 10', used to record the district link frame through which the call is to be routed, relays AR and OF, for recording second and third trials respectively, and relay TP if 2-party service is being provided.

These relays operate from grounds on their respective receiving leads, all the receiving leads being closed in the sender either to ground or to the check leads CK1, 2, 3 and 4 which in turn have ground connected to them in the marker.

Marker circuit CK1, CK2 and CK3 relays operate.

The CK1, CK2 and CK3 relays are used to check the receiving leads. Operation of these relays indicates that all the receiving leads are closed to ground. An open receiving lead by preventing the operation of one of the check relays, causes the marker to time out and actuate an alarm.

Marker circuit CK4 and CK5 relays operate.

Operation of relays CK4 and CK5 opens the locking paths for the CK1, CK2 and CK3 relays, leaving them held only by the chain circuits through the contacts of the recording relays. The CK4 and CK5 relays operated also remove ground from the CK1, CK2, CK3 and CK4 leads to the connector circuit. As these leads are connected in the sender to receiving leads not directly grounded by the sender registers, the recording relays not required for registration of the call are caused to release as follows:

Marker recording relays that are not held by direct grounds in the sender release.

One or more of these relays release at this time on all regular calls as there is no possible registration requiring all of them. This opens the chain circuit previously used to operate the CK1, CK2 and CK3 relays.

Marker circuit CK1, CK2 and CK3 relays release.

Release of the CK1, CK2 and CK3 relays as above indicates that there are no false grounds on the receiving leads not required for registration of the call. If one of these leads were falsely grounded, the false ground would be connected in the sender to the corresponding check lead and consequently to all the receiving leads of that group which were connected to the check lead. This would prevent the release of any of the recording relays of the group and the corresponding check relay would not release. In this case the marker would time out and actuate an alarm.

TRANSLATION OF OFFICE CODE TO A SINGLE INDICATION - OS 307

After the operations described above have been completed there remain operated in the marker the recording relays corresponding to the registration in the sender, the A, B, C, D and F groups of relays representing respectively the A, B and C digits of the office code, the class of service of the calling subscriber, and the district frame indication. These relays are operated in combinations as such that the numerical parts of the relay designations add up to the digit, or class or frame number, except for the B5' and F10' relays, which are provided for additional contacts. The AR and OF relays are used to indicate a second or third trial respectively and are assumed to be normal at this time on this call.

An H relay corresponding to the A ~~and B~~ digits of the code operates.

There are ~~16~~ 8 H relays in the marker, designated 2 to 9 ~~and 2' to 9'~~. Each H relay has ~~50~~ 10 "code points" wired to its contacts. The particular H relay to operate is the one corresponding to the block of ~~50~~ 10 codes which includes the code registered in the marker. This is controlled by the A1, 2, 4 and 5 relays which indicate the hundreds digit of the code ~~and the B5 and B5' relays which, when normal~~, cause the operation of an H relay designated 2 to 9 ~~and when operated, cause the operation of a relay 2' to 9'~~.

~~A TN relay controlled by the B relays operates.~~

~~There are 5 TN relays in the marker, designated 0 to 4, which operate respectively for tens digits 0 to 4 or 5 to 9. The TN relay operated reduces the possible choice of a code point to 10.~~

Ground is connected to the code point corresponding in number to the code registered in the marker.

The C recording relays connect ground to a lead corresponding in number to the units digit of the code. This ground is closed through the operated H ~~and TN relays~~ to the code point which represents the code registered.

Code points are terminals appearing in the cross-connecting fields of the marker frame. There is a code point for each ~~3~~2-digit code that can be dialed by a subscriber or keyed by an operator, numbered from 200 to 9~~9~~9. These code points are connected at the contacts of the H relays and one of them is grounded as described above for each call on which a ~~3~~2-digit code is dialed.

There are in addition two code points designated ZO and PS connected at the A5 recording relay, used to record code zero and a permanent signal indication, respectively. A third code point designated OF is connected at the A2 relay and is used to indicate sender load control calls.

Code points are cross connected to route relay windings, so that the route relay for the code can be operated for controlling the call.

Marker circuit SPT relay operates.

The purpose of the 2000-ohm resistance battery connected in parallel with the SPT relay operate battery is to make the SPT relay slow to release. However, this also tends to affect the relay at this time by making it slow to operate.

A marker circuit DF relay operates and locks, depending upon the district frame registration on the F group of recording relays.

There is a DF relay in the marker for each district link and connector frame in the office, these relays being designated 0 to 19 or as required. The DF relay to operate is controlled by the district frame indication received from the sender, and corresponds in number to the district link and connector frame through which the call is to be completed. The marginal XDF relay, connected in series, does not operate unless the windings of two or more DF relays are crossed or grounded. If it operates, due to a trouble, it sticks the circuit.

OPERATION OF ROUTE RELAY - OS 307, OS 312

The originating marker is designed to furnish a progressive means for the testing of trunks to successive trunk groups, if all trunks are found busy in the original route; and is governed by whether the marker is in a first, second or third trial call.

On this call, however, it is to be assumed that the marker is serving a first trial call and that an idle trunk will be found in the first subgroup of trunks tested.

The battery to operate the route relay is furnished through the winding of a relay used to set up the proper charge and transmission information in the district junctor. For this call the TC relay is used and indicates a charge call from a message rate line.

The R relay for the code dialed and the TC relay operate in series.

The cross connections required to operate the route relays are determined by class of service limitations and other factors. It is assumed in this case that the path to operate the R relay is traced from ground at operated contacts of the CK5 relay, through normal contacts of the CK2 relay, contacts of the C1, 2, 4 and 5 recording relays, operated or normal as required for the code registered, contacts of the operated TN relay, contacts of the operated H relay to the code point, which is cross-connected to the RC punching for the assigned R relay, through the winding of the R relay to its R punching, cross connected to an SC punching at the S relays, through contacts of the operated S relay to the corresponding S punching, which is cross-connected to the Z punching at the TC relay, through the winding of the TC relay to battery.

GROUND SUPPLY GROUPS - OS 311, OS 312, RM 5-7

The route relays of an office are subdivided into five ground supply groups. A circuit per Fig. 6 is provided for each of the first four groups and a circuit per Fig. 25 is provided for the fifth group. In the circuit per Fig. 6 for the first ground supply group, AC wiring is used, and in the circuits for the second, third and fourth groups AD wiring is used. Also in Fig. 6 for ground supply groups 1 and 2, wiring BF and BI are used, and for ground supply groups 3 and 4, wiring BF and BK are used.

For this call it is to be assumed that the R relay is in ground supply No. 3, therefore, Fig. 6 and wiring AD, BF and BK are to be used.

Ground on the normal contacts of the TB relay, through operated CK6A relay, normal OF, G3 and GS3 relays, is connected to the OB, OG, SG, CL, CR and SP punchings on the operated contacts of the R relay.

Ground on the normal contacts of the MRL relay, through the SDT, TW1, ST4 and G3 relays normal, is connected to the GE, GS and TL punchings on the operated contacts of the R relay.

Battery through 226 ohms on the operated ST1 relay, through normal contacts of TM7, TM9, ST3, TW, SDT and G3 relays, is connected to the ST punching on the operated contacts of the R relay.

OFFICE BRUSH TRANSMITTING RELAYS - OS 308

The OB punching at the R relay is cross connected to a punching at the primary or the secondary winding of one of the numbered transmitting relays OB0 to OB9. This cross-connection is made to a punching which will cause the OB group of transmitting relays to connect ground to whatever of leads OB1, OB2, OB4, SD and SD1 are required to be grounded for the particular code dialed. The OB1, OB2 and OB4 leads, if grounded, operate the OB1, OB2 and OB4 selection register relays in the sender, respectively, for controlling office brush selection. The SD and SD1 leads are used in a similar manner to operate the SD and SD1 relays respectively for setting up the station delay conditions in the sender.

Ground connected to a transmitting lead is always closed through the winding of a check relay such as OBA, OBB, OBC or OBD, these relays being used to check the continuity of the transmitting leads. The number of check relays provided in a group of transmitting relays is equal to the largest number of leads that can be grounded by this group on any one call.

Flexible cross-connections of this type permit the markers to return to the senders whatever information they may require for a given code, and they permit this information to be changed, if necessary, due to changes in routings.

The following table gives the transmitting leads grounded and the check relays used due to operation of relays OB0 to OB9 on either winding.

OFFICE BRUSH SELECTION	NUMBERED TRANSMITTING RELAYS	LEADS GROUNDED	CHECK RELAYS
0	OB0	None	None
1	OB1	OB1	OBB
2	OB2	OB2	OBB
3	OB3	OB1, OB2	OBB, OBC
4	OB4	OB4	OBB
0	OB5	SD	OBB
1	OB6	SD, OB1	OBB, OBC
2	OB7	SD, OB2	OBB, OBC
3	OB8	SD, OB1, OB2	OBB, OBC, OBD
4	OB9	SD, OB4	OBB, OBC

The office brush selection set up in the sender is equal to the sum of the numerical designations of the OB leads grounded. Relays OBO to OB4 provide office brush selection 0 to 4 respectively, and do not ground the SD lead. Relay OB5 to OB9 provide office brush selection 0 to 4 respectively and also connect ground to the SD lead.

In addition, if the cross connection from the OB punching at the R relay is made to the primary winding of any one of relays OBO to OB9, the OBP relay operates in series with the numbered relay. The OBP relay operated connects ground through the winding of the OBA check relay to the SD1 lead. If the numbered relay, however, is connected to operate on its secondary winding, the OBS relay operates in series with it and the SD1 lead is not grounded.

With the circuit arrangement described above, the OB cross connection can set the sender for any office brush selection without grounding either the SD or the SD1 lead, or it can transmit the office brush information and ground either or both of these leads. The S punching of one of relays OBO to OB4 is used when neither the SD nor the SD1 lead is to be grounded; the S punching of one of relays OB5 to OB9 is used when the SD lead alone is to be grounded; the P punching of one of relays OBO to OB4 is used when the SD1 lead alone is to be grounded; and a P punching of one of relays OB5 to OB9 is used when both the SD leads are required.

If office selections are to be skipped, the P or S punching of either the OBO or the OB5 relay is used, depending upon the requirements for the SD leads. The SO lead in this case is grounded by the OG5 relay.

The XOB relay is marginal and does not operate unless there is a cross between two or more windings of numbered transmitting relays, or a false ground on a winding other than the one used on the call. If it operates, due to a trouble, it causes the circuit to stick and call in the trouble indicator.

HIGH FIVE OFFICE BRUSH - OS 308

As previously explained in the crossbar subscribers sender text, it is possible to call for office brush selections 5 to 9 through a crossbar tandem office. When Fig. N is provided, the high five brush selection is obtained by cross connecting the SG punching on the route relay to the SG1S punching shown on Fig. N. The operation of the SG1 relay grounds the SSO lead through the SGB relay winding and causes the OB5 relay in the sender to operate and split the counting relay circuit.

When this feature is provided, all route relays in ground supply groups 1 and 3 must have their SG punchings cross connected to either the SGOS or the SG1S punchings of Fig. N. Consequently, all route relays in these ground supply groups not requiring high five office brush information will have their SG punching cross connected to the SGOS punching.

OFFICE GROUP TRANSMITTING RELAYS - OS 308

The OG punching at the R relay is cross connected to a punching at the primary or the secondary winding of one of the transmitting relays OG0 to OG4, or at the secondary winding of relay OG5. The punching at the primary winding of the OG5 relay is used only for special conditions. This cross-connection is made to a punching which will cause the OG group of transmitting relays to connect ground to leads OG1, OG2, OG4, OG5 and SO as required for the code dialed. These leads are used to set the sender for office group selection or skip office. Three check relays are provided in this group as no more than three of these leads can be grounded on any call.

The following table gives the possible combinations of relays used and leads grounded. The OGS relay operates when an S punching is used, and the OGP relay operates when a P punching is used.

OFFICE GROUP SELECTION	NUMBERED RELAY AND PUNCHING		LEADS GROUNDED	CHECK RELAYS
0	OG0	S	None	None
1	OG1	S	OG1	OGB
2	OG2	S	OG2	OGB
3	OG3	S	OG1, OG2	OGB, OGC
4	OG4	S	OG4	OGB
	OG5 -	S ----	SO ----	SD1
5	OG0	P	OG5	OGA
6	OG1	P	OG1, OG5	OGA, OGB
7	OG2	P	OG2, OG5	OGA, OGB
8	OG3	P	OG1, OG2, OG5	OGA, OGB, OGC
9	OG4	P	OG4, OG5	OGA, OGB

SD+SD1 see 3rd paragraph page 6

The office group selection set up in the sender is equal to the sum of the numerical designations of the OG leads grounded. If the cross-connection is made to the S punching of the OG5 relay, the SO lead is grounded through the winding of the OGB check relay, causing the sender to skip office selections.

The XOG relay is marginal and does not operate unless there is a cross between two or more windings of numbered transmitting relays, or a false ground on a winding other than the one used on the call. If it operates, due to a trouble, it causes the circuit to stick and call in the trouble indicator.

COMPENSATING RESISTANCE TRANSMITTING RELAYS (ORIGINAL ROUTES) - OS 308

The CR punching at the R relay is cross connected to a P or S punching of one of the transmitting relays CR0 to CR9. This causes leads CR1 to CR5 to be grounded in combinations for transmitting to the sender the compensating resistance requirements for office selections and selections beyond, and for setting the sender to use the TG or MTG relay, as required.

The leads grounded and the relays operated for the various compensating resistance conditions set up in the sender are as follows:

COMPENSATING RESISTANCE		NUMBERED		
OFFICE SELECTIONS	SELECTIONS BEYOND	TRANSMITTING RELAYS	LEADS GROUNDED	CHECK RELAYS
900	0	CR0	None	None
600	0	CR1	CR1	CRB
300	0	CR2	CR2	CRB
0	0	CR3	CR1, CR2	CRB, CRC
900	300	CR4	CR3	CRB
600	300	CR5	CR1, CR3	CRB, CRC
300	300	CR6	CR2, CR3	CRB, CRC
900	600	CR7	CR4	CRB
600	600	CR8	CR1, CR4	CRB, CRC
900	900	CR9	CR3, CR4	CRB, CRC

PRI WDG ADD CR5

When one of the relays CR0 to CR9 is operated through its primary winding, the CRP relay operates in series with it and connects ground through the winding of the CRA check relay to the CR5 lead. This causes the sender to substitute the MTG relay for the TG relay, this condition being required when a ground cutoff nonrepeating incoming selector is involved. Operation of the numbered relay through its secondary winding causes the CRS relay to operate and in this case the CR5 lead is not grounded.

The marginal XCR relay is used to detect trouble, as described for the XOB and XOG relays.

COMPENSATING RESISTANCE TRANSMITTING RELAYS (TW ALTERNATE ROUTES)

For supplying compensating resistance information from the original route relay for a 2-wire or crossbar tandem alternate route, the originating markers have been modified in the following manner: The P and S punchings associated with the SB0 to SB9 relays, shown in Fig. 14, have been disconnected from their windings and connected to the corresponding windings of the CR0 to CR9 relays. Thus, the CRP and S punching field is wired in parallel with the SBP and S field on the marker frame, making it possible to operate the CR relays from either of two points.

CLASS OF CALL TRANSMITTING RELAYS - OS 308

The CL punching at the R relay is cross connected to a P or S punching of one of the transmitting relays CL0 to CL6. This causes leads CL1 to CL4 and TW to be grounded in combinations for transmitting to the sender the class of call information and to operate or leave normal the TW selection register relay, as required.

The TW relay in the sender is operated on calls routed through a distant office selector or full selector tandem equipment to extend the time-out period for stuck sender. It is also operated to short-circuit the sender OF relay on operator class calls to trunks that normally return reversed battery during trunk test; to cause the transmission of a heavy pulse on calls from key pulsing "A" senders to certain types of operators' trunks reached directly from the distant office multiple; and on calls to an ADCl position, to cause the sender to await the display signal on abandoned calls.

The leads grounded and the relays operated for the various classes of calls are as follows:

CLASS OF CALL	NUMBERED TRANSMITTING RELAYS	LEADS GROUNDED	CHECK RELAYS
Full Selector to Panel	CL0	None	None
Full Selector to Crossbar	CL1	CL1	CLB
Restricted Code Rerouted to Operator, and Overflow except on Calls to an Operator	CL4	CL4	CLB
P.C.I. Tandem	CL3	CL2, CL4	CLB, CLD
P.C.I. Direct	CL2	CL1, CL2, CL4	CLB, CLC, CLD
Calls to an Operator Permanent Signal, and Overflow on these Calls	CL6	CL3, CL4	CLB, CLC

The CL5 relay is provided for a routing which is not used in this area.

When one of relays CL0 to CL6 is operated through its primary winding, the CLP relay operates in series with it and connects ground through the winding of the CLA relay to the TW lead, to operate the TW relay in the sender. Operation of the numbered relay through its secondary winding causes the CLS relay to operate and in this case the TW lead is not grounded.

The marginal XCL relay is used to detect trouble, as described for the XOB and XOG relays. The functions of the TWA and SP relays are given later.

TRANSMITTING INFORMATION TO THE SENDER - OS 309

With each of punchings OB, OG, SG, CR and CL at the R relay cross connected to the required point in the corresponding transmitting relay groups, a numbered transmitting relay in each of the OB, OG, SG, CR and CL groups, and a P or S relay in series in each group operates and ground through the windings of the check relays is connected to the required transmitting leads.

Closure of ground to the transmitting leads causes the required selection register relays in the sender to operate. The check relays in the marker also operate in series with them to battery in the sender, a check relay being included in each lead that is grounded.

Marker circuit TK relay operates.

The TK relay is used with the check relays to determine whether or not the transmitting leads used on the call are continuous between the sender and the marker, and are free from false grounds. Its operating path is traced through operated contacts of relays in each of the CL, CR, SG, OG and OB groups of transmitting relays, the ground being furnished in the OB group.

Within each group of relays, the A check relay should be operated if the cross connection is made to a P punching and the lead involved is not open or falsely grounded, or the S relay of the group should be operated, if the cross connection is made to an S punching, the SG group excepted. Either the A relay or the S relay closes in part the operating path of the TK relay. The remaining check relays of the group, B, C and D or B and C, if all of them are operated, close the path from operated contacts of the A or S relay to the next group or to ground in the case of the OB group. If some of the check relays are not required and consequently are normal, their contacts are bridged at contacts of the numbered transmitting relay operated in the group.

With this circuit arrangement, the operating path of the TK relay included operated contacts of a number of check relays equal to the number of leads required to be grounded. Check relays not required to be operated for a particular call are not required for operation of the TK relay for that call, as their contacts are bridged by operated contacts of S relays and numbered relays as described above.

The TK relay is slow operate in order to allow sufficient time for the register relays in the sender to operate before the connection to the sender is broken down.

If any transmitting lead required for the call should be open, the corresponding check relay in the marker would not operate. Consequently, the TK relay would not operate. A false ground on a transmitting lead required for the call, by short-circuiting the associated check relay, would prevent the operation of the TK relay in a similar manner. If the TK relay fails to operate, the marker times out and calls in the trouble indicator.

The XT and XT1 relays are provided to detect false grounds and crosses on transmitting leads not required for a call. All transmitting leads not used are connected through normal contacts of the CO1 and CO3 relays to the windings of the XT and XT1 relays, causing their operation if such leads are falsely grounded or crossed with leads used on the call. The XT or XT1 relay operated operates the XT2 relay which sticks the circuit and calls in the trouble indicator.

CHARGE INFORMATION FOR DISTRICT JUNCTOR - OS 313, OS 314

The TC relay is operated in series with the R relay on a charge call from a message rate line and this causes the TC1 relay to operate.

This path includes the winding of the marginal XC relay, provided to detect false grounds and crosses on the charge relays. It does not operate unless two or more windings of charge relays are grounded. If it operates, due to a trouble, it causes the circuit to stick and call in the trouble indicator.

Ground is connected to the TC lead to the district link and connector circuit.

This ground is connected for operating a relay in the district junctor circuit later on in the call, to prepare for operation of the line message register when the called subscriber answers.

SELECTION OF A TRUNK

SC 302

TRUNK LEVEL, GROUP START AND GROUP END - OS 327, OS 331

At the same time that the route relay causes the decoded information to be returned to the sender, it also causes the desired trunk group to be associated with the marker for test by means of the ST, TL, GS and GE punchings.

The TL punching at the operated R relay is cross connected to a TL punching at one of relays TL0 to TL14. These relays correspond to the trunk levels on the office link frames, of which there may be a maximum of ten, numbered 0 to 9 on a pair of office link frames and five more, numbered 10 to 14, on the associated pair of office extension frames, if provided. The TL relay to which the cross connection is made corresponds to the trunk level in which the desired trunks are located. Its function is to cause the pair of office frames, after they have been associated with the marker, to connect the sleeves of the trunks of the proper trunk level to the marker for test.

The GS punching at the operated R relay is cross connected to a GS punching at a TG relay in one of the circuits per Fig. 20. There are ten circuits per Fig. 20 in the marker, these ten circuits including a total of 40 sets of P, T, K and TG relays. These relays enable the marker to test the 40 trunks of a trunk level simultaneously.

An outgoing trunk group to a particular destination may consist of the 40 trunks of an entire trunk level, or any smaller even number of trunks within a trunk level. The TG relay to which the cross connection is made determines the starting point for testing the trunks, and it corresponds to the location of the first trunk to the required destination, within the group of 40 trunks.

The GE punching at the operated R relay is cross connected to a GE punching at a TG relay to determine the end point for testing the trunks. The TG relay used corresponds to the location of the last trunk to the required destination.

The 40 trunks of a trunk level are located alternately on the even and odd office link or office extension frames of the pair. A group start point is always at a trunk on the even frame and a group end point is always at a trunk on the odd frame.

If the district frame involved is an even numbered frame, the order of testing trunks is from left to right (GS to GE), but if an odd numbered district frame is involved, the order is from right to left (GE to GS).

With the TL, GS and GE punchings cross connected, the operation of the route relay causes the TL relay, corresponding to the trunk level in which the desired trunks are located, the TG relay, corresponding to the group start point and the TG relay, corresponding to the group end point to operate.

> A marginal XTL relay is included in the operating path of the TL relay, but does not operate unless two or more windings of TL relays are crossed or grounded. If it operates, due to a trouble, it blocks the call.
>
> The marginal XGS relay is in series with the TG relay, but does not operate unless the windings of two or more group start TG relays are crossed or grounded. If it operates, due to a trouble, it sticks the circuit.
>
> The marginal XGE relay is included in this path for detecting trouble as described for the XGS relay.

Ground is connected to the even and odd TL leads corresponding to the TL relay operated and to the RMR punching.

> These TL leads are multipled at all the even and odd office frames respectively but will be effective only at the pair of office frames involved in the call, due to the arrangement of the office frame marker connector relays.
>
> The marker circuit MR relay is arranged to operate from ground at the winding of the line message register, on calls from message rate lines, in order to check the continuity of the message register lead.
>
> On calls from coin stations and from key pulsing operators, the MR relay is operated and locked locally in order to cancel this test and thus avoid sticking the circuit. To accomplish this, the RMR punching is cross connected to an SC punching, providing a path through operated contacts of S relays for these classes to S punchings which are in turn cross connected to the ZMR punching to operate the MR relay.

OFFICE LINK FRAME SELECTION - OS 326

The ST punching at the operated R relay is cross connected to an ST punching of Fig. 10 associated with the pairs of office frames on which the desired trunks are located. A circuit per Fig. 10 is provided for each pair of office link frames installed. Operation of the route relay places battery on the ST lead causing the MP relay in the office link and connector circuit to operate.

> Each even numbered office link and connector frame has an MP relay for each marker, wired as shown in Figs. 6A, 6B and 6C. Each odd numbered office link and connector frame has a duplicate circuit, for emergency use. Either the regular or the emergency circuit may be used in connecting the pair of office frames to the markers, their function being to prevent simultaneous connection of the pair of frames to two or more markers.

The MP relay to operate is the one for the calling marker. It is assumed that it is on the even numbered frame of the pair on which the desired trunks are located, and that the relays of Figs. 7 and 16 are normal.

Office link and connector circuit MCA and MCB relays on both office frames of the pair operate.

Each office link and connector frame is equipped with marker connector relays MCA and MCB for each marker. The MCA relays to operate are the ones associated with the operated MP relay.

Two or more MP relays can operate simultaneously. Additional MP relays can operate with the ones for lower numbered markers already operated. The only MCA relays that can operate, however, are the ones corresponding to the MP relay operated for the lowest numbered marker.

The MCB relays to operate are the ones associated with the operated MCA relays, the grounds being furnished in the marker circuit on the even and odd MCB leads. The MCA and MCB relays operated associate the pair of office frames with the marker being used on the call.

A marker circuit O relay, corresponding to the pair of office frames selected, operates.

There is an O relay in the marker circuit for each pair of office frames installed, these relays being designated 0 to 9 or as required. The one to operate is controlled by the MCA relays operated, either of which connects ground to the corresponding OK lead to the marker. The marginal XOF relay, connected in series, does not operate unless the windings of two or more O relays are crossed or grounded. If it operates, due to a trouble, it sticks the circuit.

A marker circuit PA relay operates.

The number of PA relays provided in the marker depends upon the number of district and office frames installed, the maximum, however, being five. These relays are designated 0 to 4 or as required, the one to operate being controlled by a cross connection from the PA punching at the O relay to the PA punching at the required PA relay. They are used to provide additional contacts for use in operating a pattern relay (P), controlled by the combination of the DF relay operated and the O relay operated. The pattern relays are used for blanking out possible office junctor locations, which are not equipped between certain district frames and certain office frames.

DISTRICT LINK FRAME SELECTION - OS 326

Operation of the MP relay in the office link and connector circuit causes the MP relay in the district link and connector circuit at which the calling district junctor appears to operate.

This path is closed from battery through a resistance in the office link and connector circuit, closed over the SB lead to the marker, through the DF relay operated to the ST lead to the required district frame.

Each district link and connector frame has an MP relay for each marker, wired as shown in Figs. E, F and D. Each district frame also has a set of E relays, wired in a similar manner, for emergency use. Either the regular or the emergency circuit may be used in connecting the district frame to the markers, their function being to prevent simultaneous connection to two or more markers.

District link and connector circuit MCA and MCB relays operate in parallel.

Each district link and connector frame is equipped with marker connector relays MCA and MCB for each marker. The MCA and MCB relays to operate are the ones associated with the operated MP relay. Two or more MP relays can operate as described for the MP relays of the office frame, but the only MCA and MCB relays that can operate are the ones corresponding to the MP relay operated for the lowest numbered marker.

The MCA and MCB relays operated associate the district frame with the marker being used on the call.

CONNECTING THROUGH THE DISTRICT LINK TO THE DISTRICT JUNCTOR - OS 334, OS 335

The ground connected to the DK lead by the MCB relays is closed through the marker to the DC lead to the marker connector circuit, and through this circuit to the sender, where it operates the sender circuit DC relay. The DC lead is also connected from the sender through the sender link to the district junctor, so that the ground connected to the DK lead causes the district junctor circuit F relay and the district link and connector circuit LC relay to operate.

The operating ground for the F relay, originally closed over the DK and DC leads, is extended when the F relay operates, to the FC lead to the district link and connector circuit for operating the LC relay.

There are ten LC relays in the district link and connector circuit, each associated with the district junctors and the links appearing in one of the primary switches 0 to 9. The LC relay to operate is the one associated with the calling district junctor, as determined by the operated F relay.

The LS leads of the district links available to the calling district junctor circuit are connected to the marker.

There are ten left and ten right district links connecting the verticals of each primary switch to left and right horizontals in each of the secondary switches. The horizontals of the secondary switches are of the same number as the primary switches. The 20 LS leads designated 0L to 9L and 0R to 9R, are connected to the marker in preparation for channel testing.

The ground originally closed over the DK and DC leads, used to operate the sender circuit DC relay, the district junctor F relay and the district link and connector LC relay, is extended by operation of the LC relay to the AK lead to the marker for operating the AK and AK1 relays. Operation of these relays indicates that the "A" or district link parts of the channels have been connected to the marker.

The AK lead is closed through two contacts of the LC relay in order to check the operation of both of its halves. The strap at the No. 4 armature performs no useful function, being provided so that the strapping of the relay may be uniform.

The operating winding of the marker circuit B relay is short-circuited.

When the ST2 relay operated, the B relay closed its back contact. Operation of the AK1 relay causes it to remain normal under control of both the S and SL relays, as at this time its release winding only is energized.

TRUNK LEVELS - OS 329

While the operations in the district link and connector circuit are taking place, the trunks of the required trunk level on the office frames are connected to the marker for test.

Outgoing trunks are connected to the office link secondary switch horizontals, and to the horizontals of the office extension frames, if provided. If extension frames are provided, the office links are multipled at the link frame secondary switch verticals and at corresponding verticals of the extension frame, so that a link may be used to connect to a trunk on either frame.

The ten horizontals in each of the ten secondary switches are strapped to provide a continuous multiple across the 20 verticals, thus providing for a total capacity of 100 outgoing trunks in one bay of 10 secondary switches. This capacity may be varied by splitting the horizontal multiples at their midpoints in accordance with the trunking requirements of the central office. It may be increased to 200 by splitting all 100 horizontal multiples. The intermediate capacities are 120, 140, 160 and 180 outgoing trunks, respectively, effected by splitting the 0 and 1, 0 to 3, 0 to 5 and 0 to 7 horizontal multiples of all switches. The office extension frame has a fixed capacity of 100 outgoing trunks, the horizontal multiples never being split.

A test group, whether the associated horizontal multiples or levels are split or nonsplit, includes trunks assigned to an even level and the next higher odd level on each of the ten regular or extension secondary switches on each frame of a pair. The twenty even numbered trunks are assigned to the even numbered frame and the twenty odd numbered trunks are assigned to the odd numbered frame.

The table on RM 315 gives the locations of all test groups of forty trunks from trunk levels Nos. 0 to 14, it being assumed that all trunk levels are split. As shown in the table, the trunks are located alternately on the even and odd frames of the pair, and distributed over the left halves and the right halves of the switches.

If horizontals Nos. 0 and 1, for example, are not split, trunk level No. 1 is omitted. In this case only one test group can be assigned to these locations, as the horizontals used for the trunks of trunk level No. 0 are continuous through the switches and cannot be used in the opposite half switch for other trunks.

With respect to nonsplit trunk levels, therefore, the left and right half switch designations have no significance, except that the office link connector relays used for extending the test leads of the trunks to the marker, and the trunk testing relays in the marker are correspondingly designated.

The trunks of trunk levels Nos. 2 and 3 are distributed over the left and right half switches of the even and odd frames as described for trunk levels Nos. 0 and 1, horizontals Nos. 2 and 3 in each switch, however, being used, instead of horizontals Nos. 0 and 1. Trunk level No. 3 is omitted if these horizontals are not split.

The trunks of trunk levels Nos. 4 and 5, Nos. 6 and 7, and Nos. 8 and 9 are distributed in a similar manner, being connected to horizontals Nos. 4 and 5, Nos. 6 and 7, and Nos. 8 and 9 respectively. Trunk levels Nos. 5, 7 and 9 are omitted if the horizontals involved are not split.

Trunk levels Nos. 0 to 9 are always located on the secondary switches of the office link frames, and trunk levels Nos. 10 to 14 are always located on extension frames. As extension frames are never split, the Nos. 0 and 1 horizontals are used for trunk level No. 10, the Nos. 2 and 3 horizontals for trunk level No. 11, etc., as described for trunk levels Nos. 0, 2, 4, 6 and 8 respectively. The distribution of the trunks over the switches of even and odd extension frames is as described for the secondary bays of the office link frames, the left and right half switch designations being used, although the horizontals are continuous.

TRUNK TESTING AND TRUNK SELECTION - OS 330, OS 331

With one of relays TL0 to TL14 in the marker circuit operated and the MCA relays on the even and odd office link frames operated a TL relay and a TR relay on each office frame of the pair operate.

The TL and TR relays are used to connect the test leads of the 40 trunks of the required trunk level to the marker. On an office link frame which has all of its secondary horizontals split, 10 TL relays are provided, designated 0 to 9, each being associated with the correspondingly numbered horizontal in the left half of each of the ten switches. For example, relay TL0 is arranged to connect to the marker the test leads of the trunks wired to the number 0 left horizontals of each of the switches. Relay TL1 in a similar manner connects the No. 1 horizontals to the marker, etc. On a frame of this type ten TR relays are provided also, these relays functioning as for the TL relays but with the horizontals in the right halves of the switches.

Since the trunks of a split trunk level are connected to even numbered horizontals on one-half of the secondary switches and to the next higher odd numbered horizontals on the other half of the secondary switches, it is necessary to associate each even numbered TL or TR relay with the next higher odd numbered TR or TL relay. Odd numbered TL relays and even numbered TR relays are not furnished for horizontal levels which are not split.

The above conditions do not apply to the extension switches for they are never split. For the extension bay, there are 5 TL and 5 TR relays, each group designated 10 to 14. The TL10 to TL14 relays connect horizontals Nos. 0, 2, 4, 6 or 8, respectively, while the TR10 to TR14 connect horizontals Nos. 1, 3, 5, 7 or 9, respectively.

The following table gives the designations of the TL and TR relays which operate (on both office frames) for trunk levels 0 to 14, due to connection of ground by the marker to TL leads 0 to 14 respectively.

TRUNK LEVEL	TL RELAY	TR RELAY
0	TL0	TR1
1	TL1	TR0
2	TL2	TR3
3	TL3	TR2
4	TL4	TR5
5	TL5	TR4
6	TL6	TR7
7	TL7	TR6
8	TL8	TR9
9	TL9	TR8
10	TL10	TR10
11	TL11	TR11
12	TL12	TR12
13	TL13	TR13
14	TL14	TR14

Operation of the TL and TR relays on both of the office frames connects the S1 and S leads of the 40 trunks of the test group to the marker.

Marker circuit ~~P~~ relays corresponding to busy trunks operate from ground on the S1 leads of the trunks and the associated T relays operate.

There are 40 sets of ~~P,~~ T, K and TG relays in the marker, used for testing the 40 trunks of a trunk level and the selection of a trunk in the group. These relays are designated, in order, according to the frame and switch locations of the trunks, from EL0 (even left zero) to OL9 (odd left 9), as previously given for trunk levels Nos. 0 and 1. These frame and switch locations are always the same for the 40 trunks of a test group, regardless of the trunk level used. For example, trunk No. 0 of any trunk level is always on the even frame, left half, switch No. 0 (EL0); trunk No. 1 is always on the odd frame, left half, switch No. 0, etc.

The T ~~P~~ relays corresponding to busy trunks operate from ground on the S1 leads of the trunks, closed at a crosspoint of the secondary or extension switches.

Marker circuit SPE and SPO relays or NSE and NSO relays, for split or nonsplit trunk levels respectively, operate.

The SPE, SPO, NSE and NSO relays and their associated leads to the office frames are provided in order to insure closure of the trunk test leads to the marker before the test for an idle trunk is started. These relays are also used to indicate whether the selected trunk level is split or nonsplit. If the trunks are connected to split levels, it is necessary that this information be recorded in the marker, so that it can blank out the channels connected to the left or right half switches which are not available.

The SP and NS leads of Figs. 4, 5 and 6 of the office link and connector circuit and the NS lead of Figs. 14 and 15 are connected or left open as required so that the SP leads from each office frame to the marker are grounded if the trunk level is split and the NS leads are grounded if it is not split. The ground is closed through operated contacts of both the TL and TR relays, to check their operation; the TL0 and TR1 relays being associated in this way for trunk level No. 0, the TL1 and TR0 relays for trunk level No. 1, etc.

Ground is connected to the PC lead to the traffic register circuit.

The PC terminal at the operated R relay is cross connected to the traffic register circuit, to score a peg count register for the trunk group. Ground is connected to this lead when the JD relay operates.

Marker circuit PT relay operates.

The PT relay is made slow operate by condenser timing, in order to allow sufficient time for the ~~P~~ T relays corresponding to busy trunks to operate.

Operation of the ST2 relay connected battery and ground to the differential PT relay, causing it to close its back contact. With the TKE relay operated, operation of the SPE and SPO or NSE and NSO relays removes a short circuit from the PT condenser. Battery through the release winding of the (secondary) of the PT relay then charges the condenser, this charging current holding the relay normal. As the condenser becomes charged, this current decreases until the effect of the operate winding (primary) is stronger than that of the release winding, thus causing the relay to operate.

The short circuit is removed from the PT condenser, allowing the PT relay to operate, only if both of the required split or nonsplit relays have operated, as a check on both of the office frames.

The K relay in the marker circuit corresponding to the first idle trunk encountered operates and locks.

The number of trunks in a trunk group may be any number from 2 to 40. With respect to the marker, however, such a trunk group always consists of an even number of trunks which must be assigned in consecutive order beginning at any even number, 0, 2, 4, etc. to 38 and continuing to any odd number, 1, 3, 5, etc. to 39 as determined by the number of trunks required. When the trunk group consists of an odd number of trunks, the additional trunk included in the test group for this particular group is made busy by grounding its sleeve at the distributing frame. The trunk made busy may be the first, last or any intermediate trunk.

The leads from the first Fig. 20 that appear in the bracket "To Preceding Fig. 20" connect to leads that appear in bracket "To Succeeding Fig. 20" with the exception of leads 1, 21 and LC. Leads 1 and 21 from fifth Fig. 20 are looped back to first Fig. 20 and leads 1 and 21 from tenth Fig. 20 are looped back to sixth Fig. 20. The LC lead supplying ground is connected at first Fig. 20 and runs through the tenth Fig. 20, after which it is omitted.

This arrangement connects all the Figs. 20 into a closed circle which makes it possible for the first trunk of a group to have a higher number than the last trunk of the group. For example, a trunk group may be made up of the following trunks: 36, 37, 38, 39, 0, 1, 2, and 3; the group starts at 36 and ends at 3.

The trunks to the required destination are included between the group start and group end TG relays previously operated and are thus separated from any other trunks that may appear in the same trunk level. The trunks are tested from the group start point to the group end point (left to right through the successive Figs. 20) if the district link frame involved in the call is an even numbered frame; and from the group end point to the group start point (right to left) if the district link frame is an odd numbered frame. This is done to equalize the wear, as far as possible, on the relays of the Figs. 20 and on the crosspoints of the office switches.

If the district frame is an even numbered frame, the ground to operate the K relay is closed through operated contacts of the PT, TKE and DF relays to lead TR, through normal contacts of the AR1 relay to the group start point, operated contacts of a TG relay, to the right through operated contacts of T relays for busy trunks, if encountered, through normal contacts of the T relay for the first idle trunk, to the winding of the K relay for that trunk. If the district frame is an odd numbered frame, the ground is closed through the PT, TKE and DF relays to lead TL, normal contacts of the AR1 relay to the group end point, operated contacts of a TG relay and to the left until a normal T relay is found and to the corresponding K relay.

Ground is connected to the S1 lead of the trunk as a busy condition.

RELEASE OF MARKER CONNECTOR CIRCUIT - OS 333

When an idle trunk is found, as indicated by the operation of a K relay, the TKE relay releases causing the SR relay to operate and a release signal is sent to the sender.

Ground is closed to lock the AK1 relay and hold the AK relay in the marker, and to lock the LC relay in the district link and connector circuit and the F relay in the district junctor circuit, in parallel.

The AK, AK1, LC and F relays and also the sender circuit DC relay were held up until this time by ground from the district link and connector circuit on the DK lead to the marker, extended through the marker connector circuit on the DC lead to the sender, then on the DC lead through the sender link to the district junctor, to the FC lead to the district link and connector circuit, and to the AK lead back to the marker.

Ground from the MCB relay in the district link and connector over the DK lead, connected by the SR relay is closed in the opposite direction in order to hold these relays after the connection through the marker connector is broken.

Ground is connected to the MPC punching which is cross connected to operate a marker peg count register.

Ground is connected to the RL lead to the marker connector circuit.

Ground connected to the RL lead advances the sender, which in turn releases the connector circuit. Release of the connector opens all the leads between the sender and the marker, causing the relays in the marker to release that were held over these leads.

Ground is removed from the CKG lead.

The connector circuit removes ground from the CKG lead, releasing the CK4, CK5 and CK6 relays, at the same time that the receiving leads are opened. This circuit arrangement prevents the marker from making false operations when the relays connected to the receiving leads release.

Ground is removed from the RL leads to the connector circuit.

Ground is removed from the RL lead by the release of the CK6 relay so that if the marker seized again very quickly, the RL lead will not be grounded and give the second sender a premature release signal.

Battery is removed from the ST contacts of the R relays.

This battery is removed to prevent interference between overlapped calls, as described for the GS, GE and TL contacts. The required office frame MP relay is being held by the SR relay operated.

After release of the connector circuit the marker no longer tests busy and can be reselected. The decoding functions of a second call can take place simultaneously with the marker functions of the first call.

The second call, however, must not be allowed to progress to a point where it would interfere. For this reason, the TL relay and the TG relays operated for the first call are locked when the SR relay operates, and those required for the second call are not allowed to operate at this time.

SELECTION OF A CHANNEL

CHANNEL TESTING - OS 334, OS 335

The marker includes twenty circuits per Fig. 15 used for testing the available channels so that an idle one may be selected. The number of channels available for a call depends upon the office junctor distribution and other factors. No more than twenty channels, however, are tested at a time in any case.

A channel consists of a district link, an office junctor and an office link; the district link and office junctor terminating at the same district secondary switch, and the office junctor and office link terminating at the same office primary switch. In addition, the three parts of the channel must all be either on the left halves of the switches or on the right halves, as the district secondary and office primary horizontals are cut at the midpoint, and consequently left links and junctors cannot interconnect with right links and junctors.

Each circuit per Fig. 15 is arranged to test the three parts of a channel and to pass it by if one or more parts are busy, in order that the first channel having all of its parts idle can be selected. To accomplish this, the secondary windings of the twenty AB relays are arranged for connection, in order, to the sleeve leads of the twenty district links, the primary windings of the AB relays are arranged to be connected respectively to the sleeves of the corresponding office junctors, and the secondary windings of the C relays are used to test the sleeves of the corresponding office links. The busy condition on these circuits is ground on the sleeve, consequently any busy link or junctor causes its corresponding relay to operate, thereby preventing the marker from seizing that channel.

TESTING THE DISTRICT LINKS AND OFFICE LINKS - OS 334, OS 335

There are 10 left and 10 right district links which connect the horizontals of the 10 secondary switches (2 per switch) to left and right verticals of each primary switch, the secondary horizontals being the same number as the primary switch to which the links are connected. The 10 left and 10 right links associated with the primary switch where the calling district junctor is located are cut-in for test when the district link LC relay operates under control of the particular F relay. Any grounded LS lead of any link of this primary switch would cause the operation of the associated AB relay in the marker.

There are 10 left and 10 right office links which connect the horizontals of the 10 primary switches (2 per switch) to left and right verticals of each secondary switch, the primary horizontals being of the same number as the secondary switch to which the links are connected. The 10 left and 10 right links associated with the secondary switch where the selected trunk is located are cut-in for test when the office link LC relay operates under control of the particular K relay. Any grounded LS lead of any link of this secondary switch would cause the operation of the associated C relay in the marker.

TESTING THE OFFICE JUNCTORS - OS 334, OS 335

Operation of a K relay, in addition to causing the connector circuit to be released and the office links to be tested also causes the available office junctors to be connected to the marker for test.

Marker circuit EL, OL, ER or OR relay operates.

> The 40 trunks of a trunk level are distributed over the left and right halves of the even and odd office frames. For the first five Figs. 20, the first trunk of each 4 trunks in the trunk level is always on the even frame, left half; the second is on the odd frame, left half; the third is on the even frame, right half; and the fourth is on the odd frame, right half. For the last five Figs. 20 (in other words starting at the sixth Fig. 20) the order reverses itself and becomes even frame right half, odd frame right half, even frame left half and odd frame left half. The four K relays of each Fig. 20, consequently, are associated with corresponding frames and half switches.
>
> The 10 K relays associated with trunks in the even frame, left half, are arranged to operate the EL relay; those associated with trunks in the odd frame, left half, operate the OL relay, etc. Only one of relays EL, OL, ER or OR operate for a call, depending upon the particular K relay operated. The operated EL, OL, ER or OR relay also causes the release of the MCB relay on the office frame not required to prevent false testing of office links.

A marker circuit JC relay operates.

> The JC relays in the marker are used to operate JC relays in the district link frame, for connecting to the marker the sleeves of the available office junctors.
>
> As there is a group of office junctors connecting each district link frame to each office link frame, the number of JC relays in each district link frame, and consequently in the marker, is equal to the number of office frames installed, but always provided with a minimum of 10. The maximum number is 20, the relays being designated 0 to19 or as required.
>
> The JC relay to operate is the one corresponding to the office junctor group which connects the district link frame involved to the particular office link frame on which the selected trunk is located; this being determined by the O relay operated, which corresponds to the pair of of-

fice link frames, and by one of relays EL, OL, ER and OR, which identifies the particular frame of the pair. The JC punchings at the JC relays are connected, as required, to punchings EA0 to EA9 and OA0 to OA9 or EB, EC and ED0 to 3 and OB, OC and OD0 to 3 at the O relays. (See ED pattern layout.)

It is assumed for this step that there are no subsequent office junctor choices, therefore "W" wiring is used in Fig. 17.

The JC relay in the district link and connector circuit operates which connects the S leads of the associated office junctors to the marker.

Office junctor circuits connect verticals of the district secondary switches to verticals of corresponding office primary switches. The number of office junctors in a group varies according to the number of office frames installed, but not more than 20 are tested at one time in any case.

Any busy office junctor causes the corresponding AB relay in the marker to operate.

At this point the AB relays corresponding to busy district links have been operated on their secondary windings, those corresponding to busy office junctors have been operated on their primary windings, and the C relays corresponding to busy office links are operated on their secondary windings. The primary windings of the C relays are also used to blank out channels for which no office junctors are equipped, and also to cause the marker to pass by all left channels or all right channels when the trunk level involved is split.

TRUNK DOUBLE CONNECTION TEST - OS 332

There are two types of operation on the double connection test. The first type uses the DT2 relay of Fig. 13A and the AA wiring option shown at the DT1 relay contacts. This arrangement is used for a marker group having individual trunks or for a marker group which shares common trunks with panel office selectors. The second type is required when two marker groups share common trunks. Both these marker groups use the DT2 relay of Fig. 13B, the first marker group uses the AA wiring option at the DT1 relay contacts and the second marker group uses the AB wiring option. This explanation applies to the use of either Figs. 13A or 13B in combination with the AA wiring option.

When the ST1 relay operated it operated the DT2 relay which in turn operated the DT1 relay. When the K relay operated, it connected the operating ground for the DT1 relay to the S1 lead of the trunk. This is done to make the trunk test busy to other markers and to panel selectors on trunk groups used in common with a panel office. The double connection test is made when the EL, OL, ER or OR relay operates and causes the release of the DT2 relay.

The DT2 relay releases at this time regardless of which wiring option is connected at the contacts of the DT1 relay. When the AA option is used, the following occurs:

Release of the DT2 relay removes the operating ground for the DT1 relay, leaving its winding connected to the S1 lead of the trunk. If the trunk has been seized at some other point and the S1 lead consequently is grounded, the DT1 relays remains locked. Otherwise, the DT1 relay releases and connects ground to the S1 lead of the trunk as a busy condition.

Release of the DT1 relay connects the winding of the XS relay to the S lead of the trunk, to operate this relay in case a false ground is present. If the XS relay operates, due to a trouble, it sticks the circuit.

The S lead is tested in this manner on every call, in order to detect the presence of a possible false ground on the hold magnets. This lead, however, is only connected to outgoing trunk circuits in cases where the connection is arranged to be held by the special service, recording completing or zone trunks.

SELECTION OF CHANNEL - OS 335

Operation of the CK relay indicates that the SS and LC relays in the office link and connector circuit have operated, and the BK relay in a similar manner checks the operation of the district link and connector circuit JC relay and the registration of a nonsplit, a split left or a split right condition in the marker.

Marker circuit CHT relay operates.

The operation of the CHT relay is condenser timed, as described for the PT relay. This delay is introduced to allow time for the AB and C relays to operate.

The CH relay for the first idle channel operates and locks.

There are 20 sets of AB, C and CH relays in the marker used for testing a maximum of 20 channels. These relays are designated L0 to R9 (L0, R0, L1, R1, etc.) in order, conforming to the switch locations of the office junctors at both the secondary of the district link and the primary of the office link. Each left and right office junctor of the same designation in the group of twenty appear in the switch of the same number. Therefore, there will be two possible office junctors, one left and one right in each of the ten switches of the district secondary and office primary. These switch locations are always the same for the 20 channels regardless of the district and office frame combination. The designation of the CH relay indicates the number of the district secondary and office primary switch selected for the call.

An idle channel is indicated by the AB and C relays for that channel being normal.

The CHE relay is fast released to prevent the false operation of an additional CH relay if an earlier choice channel became idle at this time, releasing its AB or C relay.

Ground is connected to the PC lead to the district link and connector circuit.

This ground is closed through the operated LC and MCA relays in the district link and connector circuit to the PC lead to the traffic register circuit, for scoring a register which counts the number of calls made through the group of twenty district junctors.

Marker circuit DT1 relay releases.

This occurs in markers where Fig. 13B and the AB wiring are being used. The DT2 relay was previously released when an EL, OL, ER or OR relay operated.

OPERATING THE SELECT MAGNETS - OS 336

Operation of the EL, OL, ER or OR relay causes an SS relay in the office link and connector circuit to operate.

There are ten SS relays, designated 0 to 9, on each office link frame and on each office extension frame. Each one prepares the operate path of ten secondary select magnets, one in each switch, the select magnets bear the same number as the relay. The windings of the SS relays are connected through operated contacts of correspondingly numbered TL relays to the SML lead, and through operated contacts of correspondingly numbered TR relays to the SMR lead, except where certain TL and TR relays are omitted for nonsplit levels.

Operation of the EL, OL, ER or OR relay connects ground to either the SML lead or the SMR lead, causing the SS relay, corresponding with the horizontal to which the selected trunk is connected, to operate.

The marginal XSS relay is connected in series in this lead, to detect crossed SS leads. If it operates, due to a trouble, it sticks the circuit.

After a channel has been selected as indicated by the release of the CHE1 and CHE2 relays the office link and district link select magnets operate.

Ten district link secondary select magnets operate, one in each of switches 0 to 9.

The ten district secondary select magnets to operate correspond to the district links available for use on the call and have the same designation as the primary switch involved or the LC relay operated.

The district link primary select magnet (PS) for the district junctor operates. (CHE2 release)

The district junctor circuits appear at horizontals of the district link primary switches. The district junctor F relay when it operated connected ground to the M lead of the corresponding primary select magnet.

The marginal XSM1 relay is included in this path but does not operate unless two or more windings of primary select magnets are crossed or grounded. If it operates, due to trouble, it blocks the call.

Ten office link primary select magnets operate, one in each of switches 0 to 9.

The ten office primary select magnets to operate correspond to the office links available for use on the call and have the same designation as the secondary switch involved or the LC relay operated.

Ten office link secondary select magnets operate, one in each of switches 0 to 9.

The ten office secondary select magnets to operate correspond to the trunk levels in which the selected trunk appears and have the same designation as the SS relay operated.

One of these secondary select magnets will be used to close a crosspoint for the selected trunk. The other nine serve no useful purpose on this call.

TIMING FOR RELEASE OF HOLD MAGNETS

When a channel becomes idle by the removal of the make busy ground from the hold magnets and sleeve leads, an appreciable time is required to release the hold magnets fully and open the crosspoints. To avoid seizure of a circuit during this interval and a possible double connection which might result, the condenser timed HMT relay is employed to introduce a slight delay between the selection of a channel and operation of the hold magnet.

The marker circuit HMT relay operates and the HMT1 relay releases.

The HMT relay is made slow operate by condenser timing as described for the PT relay.

OPERATION OF HOLD MAGNETS - OS 337

District link primary hold magnet, corresponding to the selected channel, and the marker circuit A relay operate in series.

> When the ST2 relay operated, battery and ground were connected to the differential A, B and C relays, causing them to close their back contacts. The release windings (secondary) of these relays are stronger than their operate windings (primary), when connected in series in this manner, with no other battery or ground connected.
>
> Release of the HMT1 relay connects the negative side of the primary and secondary winding of the A relay to the LS lead to the district frame. With the hold magnet battery present and not short-circuited by a false ground, the current flow through the operate winding is increased and the current flow through the release winding is decreased sufficiently to operate the relay.
>
> If the hold magnet battery were not present, the A relay would not operate, as the current flow in its windings would not be changed. If the LS leads were falsely grounded, the operate winding of the A relay would be short-circuited and the current flow in the release winding would be increased, holding it normal.
>
> Consequently, operation of the A relay indicates that the LS lead to the district frame is connected to battery and not falsely grounded.

Office link secondary hold magnet, corresponding to the selected channel, and the marker circuit C relay operate in series.

> The C relay operates as described for the A relay. Its operation indicates that the LS lead to the office frame is connected to battery and not falsely grounded.
>
> If extension frames are provided, a secondary hold magnet and the corresponding hold magnet on the extension frame operate in parallel, and both remain operated throughout the call. The one which is effective in closing a crosspoint is determined by the operated secondary select magnets.

Marker circuit TCK relay operates.

> From ground on the TC lead supplied over the LR lead by the operated DRL relay of the subscriber sender.
>
> Operation of the TCK relay indicates that the district junctor circuit has properly recorded the charge condition set up in it by the marker. Failure of the TCK relay to operate would result in a stuck circuit.

Marker circuit MR relay operates and locks.

From ground on the MR lead from the district link and connector circuit.

This ground is furnished at the winding of the message register for the calling line. Operation of the MR relay indicates that the message register lead is continuous. If it fails to operate, it sticks the circuit.

The MR and MR1 leads are connected through the district link and connector circuit to the first and last district junctor circuits, respectively, of the ten associated with the district primary switch. These two leads are provided to indicate trouble in case an open should occur.

On operator class calls and on calls from lines not equipped with message registers, the MR relay is operated from ground at the RMR punching closed through contacts of the operated class of service.

District link secondary hold magnet and office link primary hold magnet corresponding to the selected channel operate in parallel.

Operation of the district secondary and office primary hold magnets extends their operating ground through the crosspoints to the district primary and office secondary hold magnets, causing the latter to hold or operate. They may not be fully operated at this time as their original operating paths were closed through the windings of the A and C relays respectively, this resistance acting to make them appreciably slow.

CHECK OF DISTRICT CROSSPOINTS - OS 337

Marker circuit A relay releases and SL relay operates.

Release of the A relay checks the closure of the crosspoint on the district secondary switch. Operation of the SL relay checks the closure of the crosspoint on the district primary switch, and also the recognition of a satisfactory check of the talking charge condition in the district junctor since its path is through the operated contacts of the TCK relay and then over the SL lead to the district link and connector circuit, SL lead to the district junctor circuit, where it is bridged to the S lead, through the primary switch crosspoint to ground on the S lead from the marker.

CHECK OF OFFICE CROSSPOINTS - OS 337

Marker circuit C relay releases and S relay operates.

Operation of the S relay checks the closure of the crosspoint on the office secondary or extension switch, as its path is closed over the S lead to the office link and connector circuit, through the secondary or extension switch crosspoint to ground on the S lead connected in the marker and closed through the district frame.

Operation of the SIK relay checks for the connection of ground to the S1 lead at the crosspoint.

RELEASE OF DISTRICT AND OFFICE SELECT MAGNETS - OS 335, OS 336

When the SL relay operates on the check of the district primary crosspoints and the S relay on the check of the office secondary crosspoints, both locking circuits for the SM relay are opened, causing it to release which in turn causes the select magnets in the district link and office link frames. To RELEASE

SLEEVE LEAD TEST - DISTRICT AND OFFICE FRAMES - OS 337

After the LS leads and the crosspoints have been checked the marker circuit B relay operates.

Operation of the SL relay disconnects the windings of the A relay from the LS lead to the district frame and connects them to ground, holding the relay normal. In a similar manner, operation of the S relay disconnects the windings of the C relay from the LS lead to the office frame and connects them to ground. In addition, the SL and S relays in operating each open parallel paths from the windings of the B relay to grounds at the AK1 relay. With these paths open, the windings of the B relay are connected only to the S lead to the district link and connector circuit.

This S lead is connected directly to the district secondary and office primary hold magnets, and is closed through the corresponding crosspoints to the district primary and office secondary hold magnets, and through their crosspoints (and contacts of the district junctor F relay) to the SL lead from the district frame to the marker and to the S lead from the office frame to the marker. The SL and S relays are connected, respectively, to these leads.

The battery to operate the B relay consequently comes from the windings of the district and office primary and secondary hold magnets and the marker circuit SL and S relays, in parallel. Operation of the B relay indicates that these magnets and relays and the leads are free from ground, as the presence of a false ground at any point in this circuit would prevent the B relay from operating.

The marker circuit AK and AK1 relays release causing the AK lead to be opened which in turn releases the district link and connector circuit LC relay and district junctor F relay.

Due to removal of ground from the AK lead to the district link and connector circuit and from the FC lead from the district link and connector circuit to the district junctor circuit. This also releases the sender circuit DC relay which was held up to this time over the DC lead from the district junctor circuit through the sender link to the sender. Release of the DC relay is a signal for the sender to proceed with selections beyond the office link frame.

Transferring control of the crosspoints to the district junctor circuit.

Release of the district junctor circuit F relay connects ground to the S lead to the district link and connector circuit. This ground is used to hold the district and office hold magnets during the conversation and it also short-circuits the operate winding of the B relay and increases the current flow through its release winding, causing it to release. Release of the B relay indicates that the district junctor circuit has functioned to connect the holding ground.

This ground remains connected during the conversation. When the calling subscriber disconnects, the district junctor circuit removes the ground, releasing the operated hold magnets.

RELEASE OF MARKER CIRCUIT - OS 338

The release of the marker circuit B relay causes the operation of the MRL relay under control of the DK lead from the district link and connector circuit. This controls the release of the marker relays and the relays on the district link and connector circuit and the office link and connector circuit.

The DLX relay is made slow release so that the STX relay which it holds operated will not release before the office link and connector is released, this prevents false operation of the XK and XCH relays.

OFFICE JUNCTOR PATTERNS - OS 334, OS 335

The office junctors on a district frame are always equally divided over all the office frames. The number of office junctors in a group connecting a district frame to a particular office frame can consequently be determined by dividing 200 by the number of office frames installed, any remainder being disregarded in most cases. In a central office having ten district frames and ten office frames, consequently, there are twenty office junctors in each group. In offices having less than ten district and office frames there are more than twenty office junctors in each group, and in offices having more than ten district and office frames there are less then twenty office junctors in each group.

Each district link and connector circuit JC relay has twenty contacts and can consequently connect twenty office junctors to the marker for test. If there are less than twenty office junctors in a group, which is always the case in offices having more than ten district and ten office frames, the locations on the JC relays which correspond to unequipped junctors are caused to appear busy by the operation of a P (pattern) relay. Since the unequipped locations cannot be uniform, the pattern relay selected must conform to the arrangement of the particular office junctor group which connects the particular district frame to the particular office frame used.

The circuits are arranged so that no more than ten patterns are required for any installation. These patterns, and the locations of all the office junctors on the district and office frames are shown on a series of drawings for central offices having two to twenty district and office frames. On these drawings the light face type indicates permanent connections on the office junctor grouping frame that are never changed as the office grows, and the heavy face type represents connections made by jumpers.

As shown on these drawings, the JC relays on even numbered district link frames have the same number as the office link frame to which the junctors connect. On odd numbered district link frames, however, JC relay No. 0 is used with junctors to office frame No. 1; JC relay No. 1 is used with junctors to office frame No. 0, etc., the even and odd relays for each pair of frames having their numbers reversed in this manner. This is done so that all district link frames can be manufactured with the same wiring.

A marker circuit P relay operates, corresponding to the pattern required.

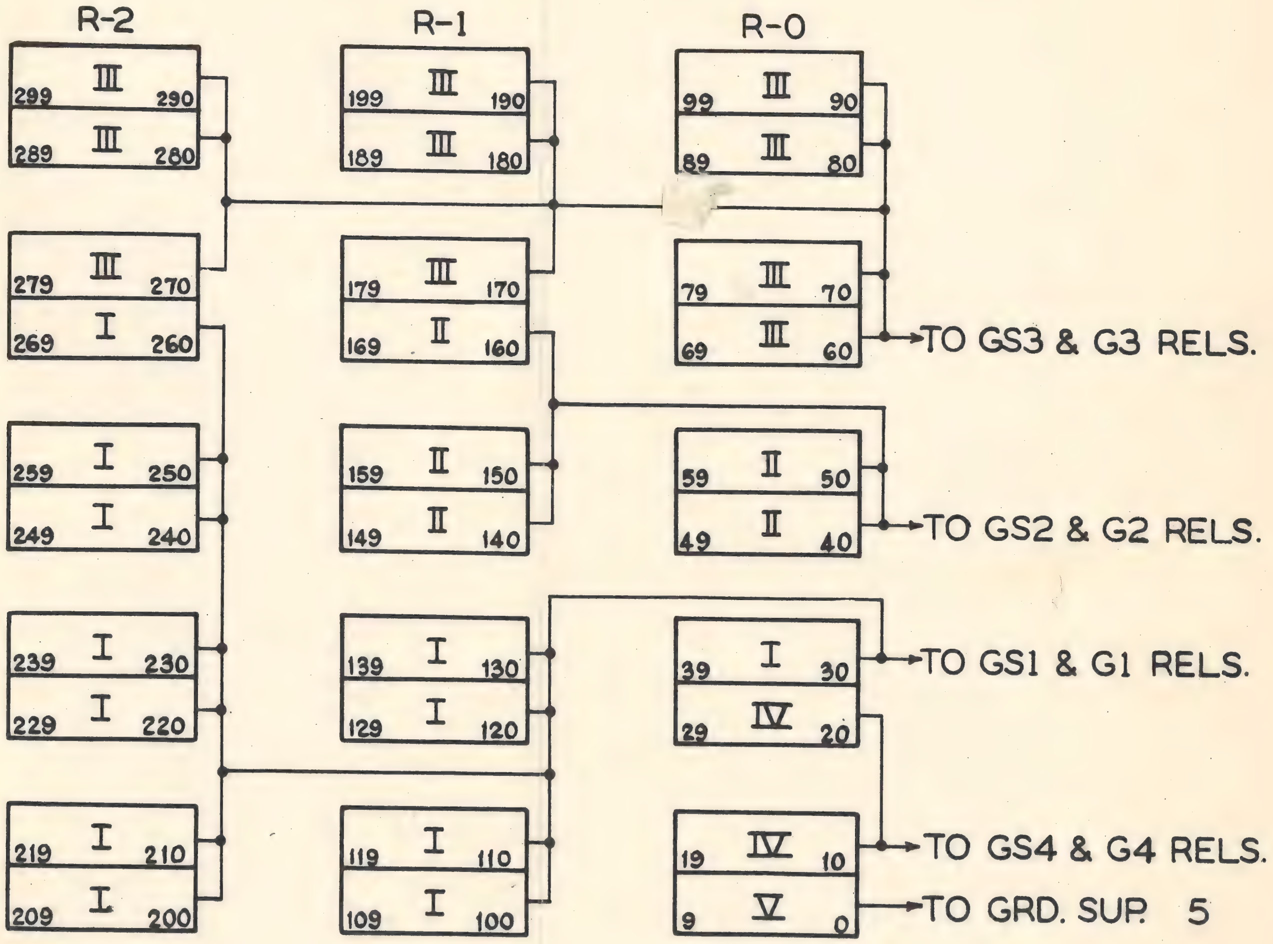
> The EAP, OAP, EEP and OEP punchings at the DF relays are cross connected to P punchings at the PA relays as required, and the PC punchings are connected to the P punchings at the P relays as required, so that the required P relay will operate under control of the DF and PA relays operated.

Marker circuit C relays operate, corresponding to unequipped positions of office junctors.

> The BP punchings at the P relays are cross connected, as required, to the BP punchings at the C relays.

BLANKING OUT LEFT OR RIGHT CHANNELS

If the trunk level involved is split, either the left or the right channels cannot be used and are caused to appear busy. This is accomplished by the operation of 10 C relays corresponding to the left channels when the SPL relay operates or the operation of the 10 C relays corresponding to the right channels when the SPR relay operates. This is controlled by the operated ER or OR relay with the SPE relay operated indicating that the selected trunk is in the right half of a split level, or the operated EL or OL relay with the SPE relay operated indicating that the selected trunk is in the left half of a split level.



TYPICAL GROUND SUPPLY ARRANGEMENT
OF
ROUTE RELAYS

[illegible]

CHAPTER 5

SECTION 3

MISCELLANEOUS INFORMATION AND FEATURES

Originating Marker Circuit SD-25016-01

MARCH 1954

FAILURE OF MESSAGE REGISTER CHECK

OPTION - FIG. AC

DENIED SERVICE - OS 337

When it is necessary to deny service to a line, the M1 lead of the line is opened at the line distributing frame. If a call is attempted with the M1 lead opened for this reason or due to a trouble, dial tone is provided as in regular operation and the call is allowed to progress without interference through the line link, sender link, sender and connector frames into the marker circuit.

The marker functions in this case as for a regular call up to the release of the AC relay. At this point the MR relay should operate from ground through the winding of the line message register, but with the M1 lead open it does not operate. Instead, the MRK relay operates receiving its operating battery from the MR relay winding. The resistance of the winding of the MRK relay, plus the associated BP resistance is high enough to prevent the operation of the MR relay.

The checking path over which the MRK relay operates is through the strapping at the secondary windings of all district junctor F- relays in the selected group. The path from ground through the winding of the message register, including the make contacts of the F- relay, for operating the MR relay is not checked. If this part of the path is open the reaction will not be as serious as an open in the part that is checked.

The MRK relay serves no useful purpose as long as the MR relay operates as it should. Its purpose is to determine as far as possible, if the message register is deliberately disconnected to deny service or if there is a trouble that prevents the MR relay from operating.

After the AC relay has released and the MRK relay has operated, the circuit continues as for a regular call, closing the selected channel, up to operation of the B relay. With the MR relay normal at this time the AK and AK1 relays are held operated, in turn holding the district frame LC relay, the district junctor F relay and the sender circuit DC relay.

When the B relay operates the CH relay releases causing the release of the hold magnets of the selected channel causing release of the MRK relay.

The RL1 relay operates connecting ground to the TRL lead.

> Ground connected to the TRL lead to the district link circuit causes the sender to make another trial on first and second trial calls. On third trial, ground on the TRL lead causes the sender to release and the subscriber's line is left connected to the district junctor, the crosspoints at the district link and office link frames, however, not being closed to a trunk.

If the line is reported for out of service the subscriber will receive routine advice for denied service.

Marker circuit RL relay operates. OS 339

The RL relay operated opens the DK lead from the district link and connector circuit, releasing the AK, AK1, LC, F and DC relays. The RX and MRL relays operate restoring the marker. The MR1 relay releases when the MRL relay operates.

For the above, the marker has treated this call as denied service, the marker releasing without a trouble indicator record.

FALSE OPEN "MR" LEAD - OS 337

If a call is attempted with a falsely opened M1 lead and the trouble condition is in the strapping between the district junctor F- relays, the call functions to the point where the MR relay should operate.

The MR relay having failed to operate from the above condition, so will the MRK relay fail to operate. In this case the MR1 relay cannot operate when the B relay operates and the marker will time out. The trouble indicator will be called in for a record which will indicate that both the MR and MR1 relays failed to operate.

If the MR relay failure to operate is due to false battery on the M1 lead or the MR1 lead, the MRK relay will operate. When the B relay operates, the MR1 relay operates and locks. The MRK relay ordinarily releases at this time, but in this case holds operated to the false battery. Since the path for operating the RL1 relay is through the back contacts of the MRK relay, the failure of this relay to release will result in a marker time out. The trouble indicator record will show the MR1 relay operated and the MR relay normal.

DOUBLE CONNECTION TEST - OS 332

The DT1, DT2 and DT3 relays are provided to detect double connections to trunks on the office multiple. The following table shows the figure and wiring options to be used and their purpose.

Case	Fig.	Wiring		Purpose
1	13A	AA		Trunks common with panel equipment.
2	13B	AB		Trunks individual to a single crossbar office.
3	13B	AA	1st crossbar office	
4	13B	AB	2nd crossbar office	Trunks common to 2 crossbar offices.

The following description applies to the first three cases cited above. During a regular call the DT2 relay operates, when the ST1 relay operates, in turn operating the DT1 relay. When the EL, OL, ER or OR relay operates, the DT2 relay releases, leaving the winding of the DT1 relay connected to the S1 lead of the selected trunk and removing the make busy ground.

As soon as the K- relay operates the temporary make busy ground is connected to the S1 lead. Therefore, the seizure by another call must be before the K- relay is fully operated.

If the S1 lead of the trunk is not falsely grounded, and if the trunk has not been seized and made busy simultaneously by a panel selector or the other crossbar office, the DT1 relay releases and again makes the trunk busy.

If there is a false ground or a make busy ground on the S1 lead of the trunk, however, it locks the DT1 relay. Release of the DT2relay in this case causes the DT3 relay to operate and lock.

The call proceeds through channel test up to the release of the HMT1 relay. At this point with the DT1 and DT3 relays operated, however, the path to operate the C relay and the office link secondary hold magnet is opened. Release of the HMT1 relay operates the RL1 relay, which on first and second trials connects ground to the TRL lead to the district link and connector circuit, causing the sender to release and make another attempt. The RL relay is then operated and opens the DK lead from the district link and connector circuit, releasing the AK, AK1, LC, F and DC relays as before. The RX and MRL relays operate, restoring the marker. On third trials, the TRL lead is also ground, but sender sets the district junctor with no channel crosspoints closed.

Where 2 marker groups use common outgoing trunks, the markers of the second office will be wired as indicated on the above table. This causes the double connection test in the second group to be delayed until after an idle channel is found. Thus, if both marker groups selected the same trunk the office "AA" wiring would make the double connection test first and finding a ground on the S1 lead would release and so allow the second office to use the trunk.

If the second office did find a false ground on the S1 lead, the marker release would be the same as described for the first office.

CROSSED JC LEADS - OS 334

The marker circuit is arranged to prevent the operation of any district link and connector circuit JC relays, in case the JC lead required for the call is crossed with some other JC lead.

After the selection of a trunk a marker circuit JC relay is operated, corresponding to the office frame on which the selected trunk is located. This relay in turn connects battery to a JC lead to the district link and connector circuit, to operate a corresponding JC relay on the district frame. In order to prevent the operation of two or more relays in the district link and connector circuit and the consequent connection to the marker for test of two or more groups of office junctor circuits, the marker connects ground through normal contacts of its JC relays to all the JC leads which are not required for a call.

Consequently, if the lead that is used for a call is crossed with any lead that is not used, the direct ground connection on the latter short-circuits the operating battery for the district JC relays and none of them operate. This causes the marker to time out and call in the trouble indicator.

SENDER TEST CIRCUIT CALLS

On calls from the sender test circuit, the marker functions must be cancelled since on such test calls the ability of the marker to close a channel is not a function of the sender. The code set up in the sender, however, by the test circuit, must be translated by the marker.

On sender test circuit calls, after having received the office code, the sender connects to a marker circuit as in a regular call. The code, district frame and class of service information are transferred to the marker as in a call from a subscriber. In addition, the sender test circuit connects ground to the SDT lead closed through the marker connector to the ST lead to the marker. This causes the following:

> The receiving and check leads are closed between the marker and the sender test circuit when the sender test connector SDT relay operates.

To prevent premature transmission of a release signal on an overlapped call the operation of the marker circuit SDT relay is under control of the normal TK relay.

To cancel the marker functions on this type of call the ground supply for the TL, GS and GE contacts of the route relay and the battery supply for the ST contacts are opened when the SDT relay in the marker operates.

The MR and DL leads are opened to avoid scoring the registers on test circuit calls.

> When the TK relay operates, after the decoded information has been transmitted to the sender, it connects ground to the RL lead to the marker connector circuit. This causes the sender to release the connector, which in turn releases the marker.

MARKER TIME OUT ON SENDER TEST CIRCUIT CALLS

In order to test the sender for proper procedure upon receiving a first, second or third trouble release signal, on certain test calls the test circuit holds ground on the CK1, CK2 and CK3 leads. This causes the marker to block and the timing circuit to function until the TM6 relay operates followed by the operation of the DL and TR relays.

Ground is connected to the TRL lead to the marker connector circuit. The marker RL1 relay operates and the marker restores to normal.

MARKER TEST CALLS

Facilities are provided in the trouble indicator circuit for making routine tests of the marker circuit. A marker can be seized for a test call by operation of the DT key and the ST key in the trouble indicator circuit. Operation of these keys causes certain relays in the trouble indicator circuit to operate and connect ground to the CIF1 and DB leads to the marker.

Marker circuit CBR, CBS and CBT relays operate causing ground to be connected to the CB leads to the marker connector circuits causing the marker circuit to test busy at all marker connectors.

> With the CIF1, CIF2 and CIE relays operated, the receiving, transmitting and check leads are connected between the marker and the trouble indicator circuit. Certain other leads are connected also, so that the trouble indicator can duplicate the functions of the sender and the district junctor, which are not connected on this type of call, even though the district and office frames are used.

In this call the marker translates the code, operates a route relay, causes the office and district frames to be connected and selects a trunk and channel as in regular operation, the trouble indicator circuit, however, providing the code and otherwise replacing the functions of the sender and also of the district junctor.

When the district link and connector circuit MCB relay operates, connecting ground to the DK lead, this ground is extended over the DC lead through the CIF1 relay contacts, operating a relay in the trouble indicator circuit. This relay duplicates the district junctor F relay in that it extends the ground back over the AK lead to operate the AK and AK1 relays. The district link and connector circuit LC relay does not operate. The trouble indicator provides a resistance battery to replace battery through the district primary hold magnet for operating the marker A relay. This battery is furnished on the DLS lead through operated contacts of the CIF1 relay. A relay in the trouble indicator circuit replaces the function of the district primary hold magnet in extending the ground required for shunting the A relay and for operating the SL relay.

When the SIK relay operates, it connects ground to the TR2 lead to the trouble indicator circuit. The trouble indicator circuit in turn connects ground to the TR lead, operating the marker circuit TR relay. The TR relay provides a locking path for the DMT relay and connects battery to the TIS lead to the trouble indicator, causing it to function for a record, the CIA, CIB, CIC and CID relays being used for this purpose.

The trouble indicator circuit then connects ground to the TIB lead, operating the marker circuit TIB relay. This relay connects ground to the TRL lead to the trouble indicator and operates the RL1 relay in the marker. The RL relay is slow operate to insure that the trouble release signal is recorded before the marker restores to normal. The RL relay causes the MRL relay to operate, which restores the marker to normal. Ground is then removed from the TRL lead, releasing the trouble indicator circuit which in turn releases the CIA to CIE relays and the CIF1 relay. The CIF1 relay released releases the CIF2 relay.

CHARGE - TRANSMISSION - ZONE
ROUTING CONDITIONS

CLASS OF SERVICE RELAYS - OS 307, OS 312

The S0 to S24 relays are provided in the marker circuit to record the class of service of the calling subscriber. One of these relays operates on each call, under control of the registration received from the sender.

The main purpose of the service relays is to make it possible to allow routes to some classes and deny them to other classes; or to deny and then supplant with another routing.

If a route is allowed to all classes it is not necessary to wire in through the service relay. This is because the charge or transmission treatment will be the same for all classes.

If a route is allowed to one class and not to another, it must be wired through the service relay as the means for this division. In this case the charge and transmission treatment will be different for each class of service.

The charge and transmission relays TC, NC, OT, KP, ZA and ZJ, etc., each having a Z punching for cross-connection, indicate to the marker circuit the type of treatment required for the completion of the call. The detail functions of these relays are as follows:

TC PUNCHING - TALKING CHARGE - OS 307, OS 312, OS 316 to OS 319

For destinations requiring normal transmission and one message unit charge from the district junctor.

As described for a regular call in Step 2, the TC relay operating in series with the R relay operates the TC1 relay which locks and connects ground from the contacts of the AC relay to the TC lead in the district link. This causes the district junctor TC relay to operate when the district link LC relay operates.

The battery for the operation of the marker TC1 relay is furnished through the winding of the marginal XC relay, provided to detect crosses and grounds.

The district junctor TC relay is not locked-in until a trunk is found to the desired destination. When the trunk is found, the operation of the marker SR relay gives a normal release signal to the sender, which causes the TC relay to be locked-in.

When the marker AC relay releases during the check of the selected channel, the TCK relay checks the TC lead for the district junctor TC relay locking ground. Its operation indicates that the district junctor has properly recorded the charge and transmission condition.

NC PUNCHING - NO CHARGE - OS 307, OS 316 to OS 320

For destinations requiring normal transmission, on which no message unit charge is required in the district junctor. (Free calls and coin classes)

These routes would be for repair service, information, official calls, etc., from message rate classes and for all calls completed through key pulsing district junctors and coin district junctors.

Under these conditions, the district junctor does not receive any charge or transmission setting from the marker as it is normally in the no-charge position.

The NC relay operating in series with the R relay operates the NC1 relay which locks and closes in part the operating path for the SL relay, thus making it unnecessary for the TCK relay to operate because no charge relay is operated in the district junctor.

Since there are no line message registers associated with coin or key pulsing classes, provisions are made to cancel the message register test and avoid sticking the marker. This is accomplished by assigning the RMR punching to the class of service SC punching and the S punching on the coin and key pulsing class relays to the ZMR punching. This causes the MR relay to operate when the TL relay operates.

OT PUNCHING - OPERATOR TRANSMISSION - OS 307, OS 316, OS 320, OS 321

For destinations which require metallic cut-through in the district junctor and disconnect control from the distant end, with no message unit charge required in the district junctor.

These routes would be for zero operator, long distance, dial and ring test, coin interzone dialing reroute, etc.

Code points representing these routes are assigned either directly to the route relay if only one group of trunks is required or through contacts of the service relays to a route relay, where a different group is required for each class of service.

The OT relay when operated operates OT1 relay which locks and connects ground to the OT lead to the district link. This operates the OT relay in the non-coin district junctor or the AO relay in the coin district junctor, when the district link LC relay operates.

On these types of calls the marker TCK relay checks the OT lead instead of the TC lead for the locking ground, as described in "Talking Charge."

ZA TO ZJ PUNCHINGS - ZONE CHARGE - OS 312, OS 313, OS 320

For routings requiring two to five initial message charges and one to two overtime message charges from the zone registration equipment, with appropriate timing for the initial and overtime periods.

The ZA to ZJ relays are assigned for different charges and duration of the timing periods, this being controlled by the rate requirements.

On these routes the R punching is assigned through the service relay contacts to the Z punching to one of the ZA to ZJ relays. These relays are used to set the zone registration common control circuit in the position to impose the required multiple charge on the calling subscribers message register.

Whichever one of these relays is operated, it in turn operates its associated ZA1 to ZJ1 relay and grounds its associated ZA to ZJ lead to the zone registration common control circuit. Any one of these relays in operating also grounds the start lead ZS to the zone registration equipment. On this type call, the ZCK relay operates to verify the talking charge condition of the zone registration circuit connected to the district junctor. The ZCK relay operated closes part of the path over which the SL relay will operate.

KP PUNCHING - KEY PULSING (DENIED ROUTE) - OS 307, OS 316, OS 317, OS 319, OS 320, OS 321

For denying key pulse operator's access to routes such as overflow, permanent signal, zero operator, vacant codes, etc.

The code points for routes allowed to subscribers but denied to operators are connected to the route relay and then to the service relays. The S punchings for classes to which the route is allowed are connected to Z punchings as required. The S punching for the key pulsing operator class is connected to the Z punching at the KP relay.

When such a code point is grounded on a call from a key pulsing operator, the KP relay operates. The R relay does not operate, due to the high resistance of the KP relay. The KP relay operated connects ground to the RO lead to the marker connector circuit and if there is no call in the marker stage, operates the KP1 relay, which locks. The grounded RO lead causes a reorder signal to appear at the calling operator's position.

The KP relay can be operated independent of the KP puncing on a key pulsing call should the operator key a code that starts with the digit "one". The A1 relay alone in the A digit relays will remain operated. When the CK1 relay releases under this condition ground will be connected through the front contact of the A1 relay operating the KP relay. The KP relay will then ground the RO lead to the key pulsing sender which causes a reorder signal to be transmitted to the "A" operator and also will cause the KP1 relay to operate and lock if there is no call in the marker stage.

TW PUNCHING - 2-WIRE

For key pulsing operator's routes to 2-wire office selector via manually selected outgoing trunk equipment.

The key pulsing "A" switchboard is equipped with jack ended outgoing trunks arranged for manual selection by the operator. Key pulsing senders having access to the markers are used with these trunks. On calls using this routing the marker is required only for transmitting to the key pulsing sender the distant office brush and group selections required, the class of call and the compensating resistance information. No marker functions are necessary as the outgoing trunks are selected manually.

Code points for codes using such trunks are connected to the R relay and the service relays as above. The S punching at the service relay for key pulsing class is cross connected to the Z punching at the TW relay.

When one of these code points is grounded on a call from a key pulsing operator, the TW relay operates in series with the R relay and locks. With the TW relay operated, operation of the TK relay, after transmission of the information to the sender, connects ground to the RL lead to the marker connector circuit, causing the sender to release the connector even though no trunk has been selected. With the SR relay normal, the ST3, ST4 and ST5 relays are prevented from operating, and the ST1 and ST2 relays release when the CK6 relay releases. The ST1 and ST2 relays in releasing release all other operated relays, restoring the circuit to normal.

The operating path of the TW relay is closed through normal contacts of the TK relay to prevent premature transmission of a release signal on a 2-wire call following a 2-wire call. The TK relay, in order to be slow operate, must of necessity be somewhat slow release. It is sufficiently slow release so that the code point for the second call can be grounded before the TK relay has had time to release on the first call. For this reason the TW relay and the route relay are prevented from operating until the TK relay releases.

PS PUNCHING - PERMANENT SIGNAL - OS 316, OS 313

For routing a subscriber's line to a permanent signal trunk when no dial pulses are recorded in the sender after a predetermined time interval.

Only one route relay can be assigned for each class of service, regardless of the number of trunks in the group. No alternate route or common subgroup is provided, as the marker does not progress to additional route relays in the attempt to find an idle permanent signal trunk.

If there is a single group of permanent signal trunks and no operator's class being served, the R relay and PS relay can be assigned independent of the service relays.

When there are two or more groups of trunks (M.R., coin, etc.) or an operator's class is served, the PS code point must be wired through the service relays.

In this area key pulsing "A" switchboard is the only operator's class involved in some crossbar offices. In these offices the PS code point is assigned to the SC punching of the service relays. The S punching on the M.R. and coin service relays is assigned to the RC punching of the R relay and its R punching assigned to the Z punching of the PS relay. The S punching on the key pulsing service relay is assigned to the Z punching of the KP relay in order to deny access to permanent signal trunks.

OF PUNCHING - LOAD CONTROL OVERFLOW - OS 316

The marker can record a call for an overflow routing on first, second or third trials by the combination of operated register relays A2 and A4. This combination is signaled by the sender to the marker when there is an originating traffic overload that has caused the sender load control feature to become operative.

When the OF punching is grounded, it causes the overflow route relay in ground supply five to operate and route the call to an overflow trunk.

OV PUNCHING - OVERFLOW - OS 307, OS 316, OS 317, OS 320

For the route relays assigned to the overflow routing provided for subscriber classes of service.

The number of overflow route relays varies depending upon whether the district supervisory relay is adjusted to hold on dial pulses.

If the district junctor will hold on dial pulses only one route relay is used and is not arranged to wait for complete dialing. In these offices, overflow tone will be connected before the completion of dialing on 4 and 5 numerical digit calls.

If the district junctor will not hold on dial pulses provide one route relay for each of the following conditions:

(a) For calls to trunk groups to destinations that do not require the dialing of numerical digits.

(b) For calls to trunk groups to destinations requiring four numerical digits.

(c) For calls to trunk groups to destinations that may require the dialing of five numerical digits or four numerical digits and a party letter.

When originating or terminating load control is provided the district junctors must be adjusted to hold on dial pulses, therefore only one route relay need be furnished.

The number of overflow trunks does not affect the number of route relays.

In addition to the above, each marker is provided with its own overflow trunk group. This is based on a maximum of 10 trunks per marker or per pair of office link frames, whichever is the smallest number provided.

The OVA relay is provided and operates when the OV operates. The OVA prevents the premature release of the district F relay by preventing the TB relay from opening the ground to the DK lead and thus holding the AK relay until the RO or TRL leads are effective in releasing the marker. It also prevents the TB relay from removing the transmitting leads ground to the sender and insures operation of relays in the sender that are necessary to make the RO lead effective in releasing the marker.

DRC PUNCHING - DENIED ROUTE - OS 312, OS 316, OS 319

For denying some subscriber's classes access to a destination to which other classes are allowed access or when it is necessary to deny all subscribers classes access to a route to which only an operator class is allowed access.

The code points for routes denied to certain classes of subscribers but allowed to other classes of subscribers or to operators are cross connected to the RC punching for the R relay and its R punching is cross connected to an SC punching. The S punchings of service relays for classes to which the route is allowed are connected to Z punchings as required. The S punchings of service relays for classes to which the route is denied are connected to the DRC punching.

When such a code point is grounded with the service relay operated for a class to which the route is denied, the DR relay operates. The R relay does not operate, due to the high resistance of the DR relay.

The DR relay operated connects ground to the DR punching which is cross connected directly to a route for intercepting the call if there is one route to the special service operator, or to the service relays and then to the route relays if there are two routes. The R punching in either case is cross connected to the Z punching at the OT relay. Operation of the DR relay consequently causes the R relay for the special service operator route to operate, and the OT relay to operate in series with it, functioning as before.

RRC 0 TO 3 PUNCHINGS - COIN REROUTE - OS 320

For destinations outside of the local area to which coin classes are allowed direct dialing priveleges. These calls are routed via panel sender tandem.

In order to use this feature, for example all code points having the same charge and station delay are arranged in code groups, as follows:

4 code groups - Codes requiring 15¢ charge and delay A, B, C or D.

4 code groups - Codes requiring 20¢ charge and delay A, B, C or D.

The eight code groups are assigned to eight separate RC punchings of assigned route relays. The R punchings of these route relays are assigned to SC punchings of the service relays, as follows:

One SC punching for 15¢ charge and delay C.
One SC punching for 15¢ charge and delay A, B or D.
One SC punching for 20¢ charge and delay C.
One SC punching for 20¢ charge and delay A, B or D.

The associated S punching of coin classes are assigned to one of the RRC 0 to 3 punching for the CRR relays, as follows:

RRC 0 - 15¢ charge and delay C.
RRC 1 - 15¢ charge and delay A, B or D.
RRC 2 - 20¢ charge and delay C.
RRC 3 - 20¢ charge and delay A, B or D.

Each associated RR punching on the CRR 0 to 3 relays is assigned to the RC punching of a route relay arranged to route the call to the 15¢ or 20¢ appearance of the dial coin zone trunks on the office link multiple and wired for either station delay A or C. The R punching of these route relays is assigned to the OT punching.

When one of these code points is used by a coin subscriber, only the associated CRR relay operates and the route relay in series is prevented from operating due to the high resistance of the CRR relay. The CRR relay operated connects ground to the RR punching, operating its associated route relay in series with the OT relay. This route relay will provide for the proper selection of a dial coin zone trunk and the station delay, for rerouting the call on a PCI basis, through panel sender tandem.

The dial coin zone trunks are connected to two separate appearances on the office link frame, one for 15¢ charge rate and the other for 20¢ charge rate. The two appearances should be on the same pair of office link frames, requiring the same ST punching assignment. This is to prevent the simultaneous selection of the same trunk by two markers.

The OB punchings of the coin class route relays requiring station delay A, B or D are assigned to provide delay A. Code points of manual offices having D delay and arranged with party letters in a particular number series cannot be assigned for routing via dial coin zone trunks.

This traffic cannot be routed through a panel 2-wire office selector or crossbar tandem office either in the route to or outgoing from sender tandem. The reason is that these circuits might time out while waiting for the operator to respond to the coin signal or for the subscriber to make the required deposit.

DIALING OPERATOR ROUTES

All routes which are not blank or denied, except those in the fifth ground supply (namely, overflow and permanent signal), are set up exactly the same as a no charge call to a subscriber.

ODR PUNCHING - OPERATOR DENIED ROUTE

Routes that are blank or denied to the dialing operator, including district test circuit code routes, are wired from the operator class of service relay contacts to the ODR punching the ODR relay operates in series with the route relay and in turn operates the OOV1 relay. The marker proceeds in its regular operation until the PT relay operates at which time the TBL relay operates through the contacts of the PT and OOV1 thereby simulating an all trunks busy condition. The markertherefore advances through the first four ground supply groups and when the TB5 relay operates, ground is connected to the marker connector RO lead on first and second trials or to the TRL lead on third trials.

OOV PUNCHING - OPERATOR OVERFLOW (AND PERM. SIGNAL)

Overflow or permanent signal routes at the dialing "A" operator class of service relay contacts are wired to the OOV punching. The OOV relay operates in series with the route relay and in turn operates the OVA relay. The marker then functions as described for an Operator Denied Route. The OVA relay provides two short paths, one of which prevents the premature release of the district F relay by shunting the break contacts of the TB relay and preventing the DK lead ground from being cut off, thus holding the AK relay until the RO or TRL lead are effective in releasing the marker. The other path prevents the TB relay from opening the ground for the transmitting leads to the sender and thus insures the operation of the relays in the sender that are necessary to making the RO lead effective in releasing the marker.

CP PUNCHING - CONTACT PROTECTION

These punchings provide contact protection for certain marker relay contacts associated with the highest calling rate code points.

The CP punching has connected to it a .5MF condenser in series with 1500 ohms resistance to ground. They are assigned in parallel to the code points needing contact protection.

PROVISION OF ROUTE RELAYS

OS 310, OS 311, OS 312, OS 317 TO OS 324

As already stated, "The originating marker is designed to furnish a progressive means for the testing of trunks to successive trunk groups, if all trunks are found busy in the original route."

In order to provide this type of testing, the route relays associated with one marker are arranged in five ground supply groups. The number of route relays in each ground supply group is dependent on the route requirements of the local office.

The ground supply grouping arrangement allows the marker to utilize different routes for originating calls to the same destination.

After determining the number of route relays required for the destination, it is necessary to determine the ground supply groups in which these route relays must be assigned.

In areas having several tandem centers it is possible to use the multialternate routing method. This method utilizes the tandem centers as alternate routings, by employing as many as four different routes for the same destination.

A destination may be reached successively over direct trunks, 2-wire office selectors or crossbar tandem trunks, panel sender tandem trunks and then trunks to a succeeding panel sender tandem center.

At this point it can be stated that there are two types of routing. Original routings, which are direct trunks to the destination and alternate routings which go via a tandem center to the destination.

Various combinations of one, two or three alternate routes may be employed. When all three or less are used for one destination they will be known as first alternate, second alternate and third alternate routes.

SIZE AND SUBGROUPING OF TRUNKS

The number of trunks for a route affects the provision of route relays, as follows:

(a) A maximum of 40 trunks arranged in one group, uses one route relay.

(b) A maximum of 80 trunks arranged in two subgroups, uses one route relay.

(c) A maximum of 520 trunks arranged in 3 to 13 subgroups, uses two route relays. One route relay serves 2 to 12 subgroups known as individual subgroups. The other route relay in a higher numbered ground supply group serves one subgroup known as a common subgroup.

Destinations having different charge conditions but having the same station delay and the same alternate route conditions; which are served by the same panel tandem trunks, may be assigned to the same common subgroup route relay.

(d) A maximum of 480 overflow or permanent signal trunks, arranged in 3 to 12 subgroups, uses one route relay. These route relays must be located on the first route relay bay due to the cross-connection arrangement.

Insofar as overflow trunks, it is the practice that each marker shall have its own trunk group.

(e) If there is an alternate route, the same conditions outlined in (a), (b) and (c) apply for the alternate route.

GROUND SUPPLY GROUPS

OS 310, OS 311, OS 312, OS 317 TO OS 324

The route relays are subdivided into five ground supply groups. The route relays in each of the first four groups are multipled at their armatures and then wired to their respective ground supply group relays G1 and GS1 to G4 and GS4.

The route relays in the fifth ground supply group are also multipled at their armatures, part of them being permanently grounded, but none of them being controlled by a G and GS relay. This group is used exclusively for overflow and permanent signal routes.

The G1 and GS1 relays have AC wiring, and the G2 to G4 and GS2 to GS4 relays have AD wiring. In addition, ground supply groups 1 and 2 are equipped with BF, BI and CG wiring while groups 3 and 4 are equipped with BF, BK and CG wiring.

The purpose of the G and GS relays, when operated, is to cancel the information recorded in the sender and the marker from the operated route relay, when the trunks associated are found busy so that a succeeding route relay (if available) may be used.

Each of the five ground supply groups has one TB- relay, these relays being designated 1 to 5. Their purpose is to record the all trunks busy condition in their respective group.

The detail operations for the G-, GS- and TB- relays are explained later.

RM 5-~~6~~ 7 typically illustrates how route relays, in groups of ten, are integrated into different ground supplies. The R0-R1-R2 indicates the route relay bay number, the numbers 0-299 are the individual route relays and the Roman numerals show the ground supply that each group of ten is in. This chart shows the reverse or cable side of the route relay bays and the interconnecting lines are 15 conductor cross-connectable cables that can be rearranged if it is determined that one ground supply needs additional route relays in it while another ground supply does not need all the route relays that are in it.

ORIGINAL ROUTES - OS 312, OS 317

For original direct routes having no alternate route, the route relay, if there is only one, is in ground supply group No. 3. If there are two route relays, the first choice route relay is in ground supply group No. 3 and the second choice (common) is in ground supply group No. 4.

Original direct routes that have alternate routes, the original relay, if there is only one, is in ground supply group No. 1. If there are two route relays, the first choice route relay is in ground supply group No. 1 and the second choice is in ground supply group No. 2.

Original route relays usually are not assigned in ground supply group No. 3 when the destination has an alternate route. This is for the purpose of selecting the alternate route on second trial calls, if due to a trouble the original route has caused a time-out.

Original route do not necessarily have to be direct routes. They can be to a 2-wire office center, crossbar tandem, or to a panel tandem office, from which point the direct trunks are selected. Their route relay treatment is the same as original direct routes.

Original route via panel tandem require one route relay for not more than two subgroups, for all destinations reached through the tandem point, requiring the same:

(a) Zone charge.

(b) Station delay.

(c) Alternate or overflow route relay.

For a common subgroup of tandem trunks, one route relay is used for all destinations reached through the tandem point requiring the same:

(a) Station delay.

(b) Alternate or overflow route relay.

All individual route relays arranged for different charge conditions may use the same common subgroup route relay if they all require the same station delay and alternate or overflow route relay.

ALTERNATE ROUTES - OS 318, OS 319

Alternate routes can be in ground supply groups Nos. 2, 3 or 4 depending upon the original route requirements. Alternate routes can be 2-wire office, crossbar tandem or panel tandem, except that a 2-wire or crossbar tandem alternate serving as a common group for a number of original routes cannot include a 2-wire office or crossbar tandem in the original group.

For 2-wire or crossbar tandem alternate routes having original direct routes provide one route relay for each group of destinations reached through the 2-wire or crossbar tandem office center, having the same subsequent alternate route than a panel sender tandem.

PERMANENT SIGNAL ROUTES

Permanent signal routes only appear in ground supply group No. 5. One route relay is used for each class of permanent signal trunks, such as coin and non-coin. The number of trunks in any one class of trunk group does not affect the permanent signal route relays, because only one trial is made by the marker in an attempt to find an idle permanent signal trunk and it cannot progress to additional route relays.

OVERFLOW SIGNAL ROUTES - OS 316

Overflow signal routes only appear in ground supply group No. 5. The number of overflow trunks does not affect the number of route relays for the same reason as explained for permanent signal routes.

If the district junctor will hold on dial pulses only one route relay is used and is not arranged to wait for complete dialing. In these offices, overflow tone will be connected before the completion of dialing on 4 and 5 numerical digit calls.

If the district junctor will not hold on dial pulses provide one route relay for each of the following conditions:

(a) For calls to trunk groups to destinations that do not require the dialing of numerical digits.

(b) For calls to trunk groups to destinations requiring four numerical digits.

(c) For calls to trunk groups to destinations that may require the dialing of five numerical digits or four numerical digits and a party letter.

Under other routings it was necessary to treat these conditions in accordance with the proper station delay, in order that the sender count time accordingly.

For the overflow route, only one route relay is provided for all three conditions and treated on the basis of (a), and wired for C station delay. This will result on some calls in group (b) and (c) terminating before dialing is completed, the subscriber receiving overflow tone while still dialing.

Overflow trunks are arranged so that any marker will have ready access to them without being locked out of the office frame from another marker. A trunk group is assigned for each marker and the groups are located on different pairs of office link frames.

FOR ROUTES FROM KEY PULSING "A" SWITCHBOARDS DIRECT TO 2-WIRE OFFICE SELECTORS OR CROSSBAR TANDEM OFFICES

The number of trunks does not affect the number of route relays, as the operator plugs directly into the trunk and the marker is called in only for decoding, having no marker functions to perform on this class of call. The OB, OG, SG, CR and CL terminals on these route relays are cross connected as required. The remaining terminals are not cross connected.

These routes are not expected to have alternate routes except by plugging into another group of trunks.

FOR ROUTES OVER "A" SWITCHBOARD DISTRICT JUNCTOR CIRCUITS

The route relays for these trunk groups are provided on the same basis as outlined for the routes used by subscribers. Routes used in common by subscribers and key pulsing "A" operators make use of the same route relays. However, the "A" operators may have routes which are for their exclusive use and for such routes the route relays are provided on the same basis as for any other route off the crossbar office multiple. Such route relays are operated through the contacts of the class of service relay for key pulsing "A" operator class, these routes being denied to subscribers by operation of their class of service relays which cause the DR relay to operate when one of these codes is dialed. The DR relay causes the call to be routed to a special service operator as described under "DRC - Denied Route."

OPERATING SUCCEEDING ROUTE RELAYS

RA PUNCHING - ROUTE ADVANCE - OS 312

The RA punching associated with the route relay contacts is for the purpose of operating succeeding route relays, should all its trunks be found busy or should a second or third trial call enter the marker.

The RA punching of the original route relay is assigned directly to the RC punching of the next succeeding route relay, this being either a common original or a first alternate or the overflow route relay.

The RA punchings of the overflow and permanent signal route relays of ground supply group No. 5 are not cross connected.

Common original, first alternate, second alternate, third alternate and overflow route relays are never operated over a direct connection from a code point. They are operated only by a path from a grounded code point closed over cross-connections from RA punchings of route relays in preceding ground supply groups.

The RA punching of a route relay is not grounded and is therefore ineffective to operate a succeeding route relay unless a trunks busy condition is encountered, or unless the sender is making a second or third trial.

ZAR PUNCHING - OS 312, OS 317 to OS 320

For all route relays that are operated from an RA punching, except on the overflow route relays, the R punching of these route relays are assigned to the ZAR punching for their operating battery. This is because the charge and transmission relay operated for the original route remains operated.

SP PUNCHING - SPECIAL

The SP punching is provided to take care of certain special conditions which are involved in the provision of alternate routes and the subgrouping of trunk groups. The SP punchings of route relays are cross connected to punchings SPA, SPB, OG-5-P, OG-5-S, or TWB. The SP punchings of route relays in ground supply group No. 5 are not cross connected.

CHAPTER 5

SECTION 4

MISCELLANEOUS INFORMATION AND FEATURES

Originating Marker Circuit SD-25016-01

MARCH 1954

SECOND TRIAL

RECORDING SECOND TRIAL INDICATION - OS 341, OS 342

The sender is released by a trouble release signal, which is the connection of ground to the TRL lead or the RO lead, as follows:

CONDITION	TROUBLE INDICATOR	TRL LEAD	RO LEAD
All Trunks Busy 1st Trial	Not Connected	-	Used
All Permanent Signal Trunks Busy 1st Trial	Connected	-	Used
All Channels Busy 1st Trial	Not Connected	Used	-
Trouble Time Out 1st Trial	Connected	Used	-

The sender is arranged to make a second trial after receiving a trouble release signal for any reason except due to all trunks being busy. It also makes a second trial after receiving a regular release signal if it encounters an overflow or telltale condition.

On a second trial call the first trunks to be tested are those associated with a route relay in ground supply group No. 3, whether they are original or alternate route trunks.

The marker records the office code dialed, the class of service of the calling subscriber and the district frame number as described for a first trial call. The sender, however, connects ground to the AR lead, causing the marker AR relay to remain operated after the check of the receiving leads is completed. When the ST1 relay operates with the AR relay operated, the BF, G1, G2, GS1 and GS2 relays operate.

> When the ST1 relay operates, the G1 and G2 relays lock and the GS1 and GS2 relays hold in parallel, respectively.

FOR ROUTES WITHOUT ALTERNATES - OS 317

If the code dialed is one for which no alternate route is provided, the original route relay in ground supply group No. 3 operates as in a regular call, and in this case operation of the G1, GS1, G2 and GS2 relays has no effect. The marker attempts to complete the call over the original route as if it were a first trial, except that due to the AR1 relay being operated the order of testing the trunks is reversed, and due to the AR2 relay being operated, channel testing starts at the eleventh Fig. 15, progressing to the twentieth and then from the first to the tenth.

If the trunk group is not subdivided, the call progresses to the overflow trunk group, as explained under trunks busy conditions. If it is divided into two subgroups, both are tested and then, if necessary, the call is routed to the overflow trunks. For trunk groups divided into three subgroups, one of those associated with the group relay in ground supply group No. 3 is tested, and if it is found busy the marker progresses to the associated route relay in ground supply group No. 4 and then, if necessary, to overflow.

FOR ROUTES WITH ALTERNATES - OS 318, OS 319

If the code dialed has an alternate route, the original route relay in ground supply group No. 1 operates as in a regular call. However, with the G1, G2, GS1 and GS2 relays operated, ground is removed from all the contacts of the route relays in ground supply groups No. 1 and No. 2 except the RA contacts, which are grounded by operation of these relays. Consequently, the route relay operated in ground supply group No. 1 is ineffective to route the call. If there is an associated route relay in ground supply group No. 2, it operates from battery at the ZAR punching, cross-connected to the R punching, through the winding of the route relay, RC punching, cross-connected to the RA punching of the operated route relay in ground supply group No. 1, operated contacts of this relay, operated contacts of the G1 relay, normal contacts of the TB1 relay, TB1 lead, connected to the TB2 lead, operated contacts of the GS2 relay, G2 lead to operated contacts of CK6 relay to ground. This route relay, however, is also ineffective to route the call with the G2 and GS2 relays operated, but its RA punching also is grounded.

Consequently the alternate route relay in ground supply group No. 3 operates, as it is cross-connected to operate from the grounded RA punching of the operated route relay in ground supply group No. 2, if there is one, or from the operated route relay in ground supply group No. 1 if only one route relay is provided for the original route trunks.

From this point the call proceeds as described for routes without alternates, starting at the trunks associated with the route relay operated in ground supply group No. 3, these trunks, however, being the alternate route trunks in this case. The direction of testing the trunks is reversed and the start and end points of channel testing are changed. The progression to other subgroups, if any, and to the overflow trunks is explained under trunks busy conditions.

If the alternate route in ground supply group No. 3 is through a 2-wire office center and the original route is direct, the office brush and group selections are obtained from the original route relay. In this case the SP punching of the alternate route R relay in ground group No. 3 is cross-connected to operate the TWA relay which releases the GS1 relay even though the circuit is set for a second trial. Also, the SG punching of this route relay is cross-connected to the SPB punching, in order that ground will be supplied to the OG punching on the original route relay in ground supply No. 1 on second trial calls.

DISCONNECTION - OS 338

Except for the features as described and the release of the additional relays used, the action of the marker on a second trial call is the same as for a first trial. An RO lead signal is returned if the call progresses to the overflow trunks and they are all busy.

THIRD TRIAL

OS 341, OS 342, OS 310 TO OS 312

Subscriber's senders are arranged to make a third trial after receiving a trouble release signal on a second trial (ground on TRL lead), all channels busy (ground on TRL lead), trouble time out (ground on TRL lead) or after receiving a regular release signal if an overflow or telltale is encountered. Key pulsing senders are arranged to make only two trials.

On a third trial call the overflow trunks alone are tested. In this case the sender connects ground to both the AR and OF leads, so that the marker AR and OF relays remain operated after the check of the receiving leads is completed.

With the AR relay operated, the G1, GS1, G2, GS2, BF, AR1 and AR2 relays operate as for a second trial. With the OF relay operated, the G3, G4, GS3 and GS4 relays operate.

> When the ST1 relay operates the G3 and G4 relays lock and the GS3 and GS4 relays hold in parallel, respectively.

The OF1 relay operates and locks, then the TRL lead is closed and the RO lead opened at the TB5 relay.

> The TRL lead is used on third trial calls for any trouble release signal from the marker.
>
> The G and GS relays for ground supply groups 1 to 4, operated as above, causes ground to be connected to the RA contacts of the route relays in these ground supply groups, and they disconnect ground from the contacts used for transmitting information to the sender and connecting to a trunk group.
>
> In this case the first original route relay, in ground supply group No. 1 or No. 3, operates as in a regular call, but is ineffective except for its RA punching. Second choice common original and alternate route relays operate in turn, if provided, in the order of the ground supply groups, the last one furnished having its RA punching cross-connected to operate the required overflow route relay. In this manner, testing for an idle trunk is immediately extended to the overflow trunks in the fifth ground supply group, the original route trunks, and the alternate route trunks, if provided, being passed by. The AR1 and AR2 relays operated function as described for a second trial to reverse the order of testing the trunks and to change the start and end points for channel testing.

The call proceeds from this point as described for overflow, except that, if all the overflow trunks are found busy, the TRL lead trouble release signal is sent. This causes the sender to restore to normal, leaving the calling subscriber connected to the district junctor.

TRUNKS BUSY CONDITIONS
ON ORIGINAL ROUTES NOT HAVING ALTERNATE ROUTES

TRUNK GROUPS NOT SUBDIVIDED - OS 310, OS 311, OS 325, OS 331

One route relay is provided for each trunk group of not more than forty trunks. This route relay is in ground supply group No. 3 for an original route that does not have an alternate route.

In this case the SP punching at the R relay does not require a cross-connection. (The OG punching at any R relay in ground supply No. 3 receives its ground by means of the BF and BK wiring option.) The other punchings at the R relay are cross-connected, the RA punching being connected to the RC punching of the required overflow route relay in ground supply group No. 5.

It is assumed that the call has progressed up to operation of the PT relay for the selection of a trunk, but that due to all the trunks being busy, all the T relays are operated and therefore no K relay can operate.

The TBL relay operates due to the operation of the PT relay with all the T relays operated.

The operating battery for the K relays is disconnected.

> The operating battery for the K relays is disconnected to prevent the selection of a wrong trunk. This might otherwise occur if a trunk in the group just tested and found busy should become idle, releasing its T relay and causing the corresponding K relay to operate, while the marker is advancing to test another trunk group. In this case the operated K relay would lock, and the marker would continue to advance to test the next trunk group. If the trunk in the new trunk group corresponding to the wrongly operated K relay should not happen to go to the desired destination, a wrong number or a stuck sender would result.

The operating battery for the district link JC relays is disconnected from the contacts of the marker JC relay.

Ground is removed from the transmitting leads releasing the operated sender register relays.

> This is not only to release these relays in the sender but to allow time for the energy in their windings to be dissipated before the TB relay operates. This is to prevent the XT and XT1 relays from operating falsely, due to the inductive discharge from the windings of the sender relays.

The TB relay in the marker operates and the DC lead to the marker connector is opened.

Opening of the DC lead releases the sender circuit DC relay, the district junctor circuit F relay, the operated LC relay in the district link and connector circuit and the marker AK and AK1 relays.

On this call the marker will attempt the selection of a trunk in another trunk group (in this case the overflow trunk group) and will release the district frame momentarily before connecting to the office frames on which the other trunks are located. The DC lead is opened so that the F relay will be fully released before the marker disconnects from the district frame to prevent it from remaining falsely operated if the district frame should be seized, immediately upon its release, by another marker.

The SR relay operating ground is opened, the operated transmitting relays release and the MCB relays of both office frames release.

The marker circuit TB3 relay operates and locks.

Ground is connected to the OF punching at the operated route relay.

The OF punching is cross-connected to score an overflow register for the trunk group.

Ground is removed from the PC lead to the traffic register circuit.

Marker circuit G3 and GS3 relays operate causing the operated TL and group start and group end TG relays to release and removes battery from the ST lead to the office link and connector circuit.

Removal of battery from the ST lead releases the office frames, which in turn releases the district frame.

When the PT relay releases it causes the TBL relay to release.

The TBL relay releases when the PT relay releases, providing that the district link frame has released removing the locking ground from the DK lead. This is to insure that another office link frame will not be called in until the district link has released.

Marker circuit TB and TB3 relays release.

Release of the TB3 relay with the G3 relay operated causes ground to be connected to the RA punching of the operated route relay. In this case, under the assumed condition that no second common original route relay is provided, this RA punching is cross-connected to the RC punching of the required overflow route relay in ground supply group No. 5.

The R punching of the overflow route relay is cross-connected to an SC punching, and the corresponding S punchings are connected to the Z punching at the OV relay for subscriber's classes, or to the Z punching at the KP relay for operator classes. Consequently, the following takes place for a subscriber's class of call:

The required overflow route relay and the OV relay operate in series.

If the original routing required ground on the TC lead to the district junctor (charge call from a message rate line), this condition is not changed due to the overflow routing, as an overflow trunk cannot cause a district junctor circuit to score the message register. In this case, the TC and TC1 relays remain operated, the TC relay being held in series with the original route relay.

However, if the original routing required ground on the OT lead this condition is cancelled, as follows, as a district junctor will not hold when connected to an overflow trunk if set for operator talking.

Marker circuit OVA and NC1 relays operate and the OT1 relay releases.

Ground is removed from the OT lead to the district link and connector circuit.

Removal of ground from the OT lead causes the district junctor circuit to cancel the operator talking condition. The marker circuit OT relay remains operated in series with the original route relay, but without effect. The NC1 relay operated closes in part the operating path for the marker SL relay, making it unnecessary for the TCK relay to operate.

The overflow route relay operated returns to the sender the information which it requires for completing the call to an overflow trunk. The overflow route relay is cross-connected to provide the same class setting as the operator codes, so that the sender will advance for trunk test with only the code dialed.

The overflow route relay is cross-connected to skip office selections. This cross-connection is made from the OG punching to the S punching of the OG5 relay. The SP punching of the overflow route relay is not cross-connected.

The marker advances from operation of the route relay as for a regular call, connecting to the district and office frames as before, except that the call is routed to an overflow trunk instead of an outgoing trunk. If an idle overflow trunk is found, the marker tests for an idle channel, connects the district junctor through it to the trunk, and restores to normal. The overflow route relay and the OV relay release when the CK6 relay releases. The G3 and GS3 relays release when the ST5 relay operates. The NC1 relay, if operated, releases when the district link MCA and MCB relays release.

Overflow trunks have tone connected through interrupter contacts and a resistance to the tip and ground connected through a resistance to the ring, to provide the paths busy signal.

For an operator class of call, the overflow route relay is connected in series with the KP relay. Consequently, on a trunks busy condition in a call of this class, the overflow route relay does not operate, due to the high resistance of the KP relay. The KP relay operates, however, providing a reorder signal.

ALL OVERFLOW TRUNKS BUSY

OS 310, OS 311, OS 331

Only one subscriber's line can be connected to an overflow trunk at one time. If, due to exceptional conditions, all overflow trunks associated with one marker should become busy on first or second trial as indicated by the OF1 relay being normal, the marker grounds the RO lead to the sender. If the marker is on third trial, as indicated by the OF1 relay being operated, the TRL lead is grounded.

It is assumed in this case that the required overflow route relay has been operated as described above, that the office frames on which the overflow trunks are located have been connected to the marker, and that the trunk level, group start and group end points have been determined as before. With all trunks busy, the TBL relay operates when the PT relay operates, causing the following, provided that the overflow trunk group is not subdivided:

Marker circuit TB and TB5 relays operate, the MCB relays in the office link and connector circuits release. Ground is connected to the OF punching at the operated route relay to score an overflow register.

Ground is connected to the RO lead to the marker connector circuit, on first or second trial calls or to the TRL lead on third trial calls.

On either the RO or TRL lead being grounded no further trials are made, instead the sender advances the district junctor and cancels the trunk guard test. No connection is established between the district junctor and an outgoing trunk. The subscriber will remain connected to the district junctor with no possible signal for disconnection.

If the overflow trunk group is divided into two subgroups, the TB relay is not operated unless all of the trunks in both subgroups are found busy. The two subgroups of trunks are tested in this case as described for outgoing trunk groups similarly divided.

ROTATION OF CALLS TO TRUNK SUBGROUPS

OS 325, RM 316

The relays in Fig. 16 are provided if there are any trunk groups divided into two or more subgroups.

The circuit is divided into two main functions and either one or both can be provided for a particular job. The two functions separate into routes with two or three subgroups and routes with four to thirteen subgroups.

In the first case 80 trunks are available for testing from one route relay and 40 from a second route relay which is known as the common subgroup, making a total of 120 trunks. In the second case 480 trunks can be tested from one route relay and 40 from a second route relay which is also the common subgroup, making a total of 520 trunks.

In the first case, the marker can be made to test both subgroups in the original route ground supply before advancing to the common subgroup. In the second case, only one subgroup is tested in the original route ground supply before the marker advances to the common subgroup.

Relays GP-0A and GP-1A of Figs. 5 are furnished for fifteen groups of trunks each having two or three subgroups and relays GP-0B and GP-1B are furnished in addition if there are 16 to 30 such trunk groups.

Relays G-0A to G-11A of Fig. 9 are furnished for three groups of trunks each having 13 subgroups.

Relays G-0B to G-11B of Fig. 9A are furnished for three groups of trunks each having four subgroups.

Relays G-0C to G-11C of Fig. 9B are furnished for three groups of trunks each having five subgroups.

To complete one cycle of Fig. 16 it requires 12 marker calls. The operating and releasing of the CK4, CK6 and CK6A relays furnish the major controls.

TRUNK GROUPS DIVIDED INTO TWO SUBGROUPS

ONE SUBGROUP BUSY - OS 325, OS 317, OS 310, OS 311, OS 331

The GWO and GZO relays and the GP- relays, in addition to controlling the distribution of calls are used to provide for testing the second subgroup of trunks associated with a first choice route relay (original or alternate), if the first subgroup tested is found busy.

It is assumed that the trunk group is for an original route not having an alternate route; therefore the route relay is in ground supply group No. 3.

To accomplish this, for an original route not having an alternate route, the SP punching of the route relay is cross-connected to the SPA punching (if office selections are required) to provide for the testing of both subgroups.

The OG punching is cross-connected, as required, to any P or S punching at the office group transmitting relays, except the OG5 P and S, to provide the office group selection information. The RA punching is cross-connected to the RC punching of the required overflow route relay.

If no office selections are required, the OG5 P or S punching is cross-connected to the OG punching of the route relay to provide the skip-office information. For this condition it will not be necessary to cross-connect the SP punching since the testing of one or two subgroups can be provided for by the OG5 S punching or the OG5 P punching, respectively.

It is assumed that the call has progressed up to operation of the route relay, with either the GP-0A and GP-0B relays or the GP-1A and GP-1B relays having been operated.

When the route relay operates the SP and GT1 relays operate.

> The path of the GT1 relay is traced through contacts of the GW0 and GZ0 relays, one of which is operated and the other normal. The GT1 relay operated opens the operating path of the TB relay and prepares for the testing of the other subgroup in case all of the trunks in the first subgroup tested are found busy.

When the PT relay operates for the selection of a trunk with the GT1 relay operated, and under the assumed condition that all the trunks in the first subgroup tested are found busy, the TBL relay operates and removes ground from the transmitting lead to the sender.

Marker circuit GT2 relay operates and locks.

> The DC lead to the marker connector is opened, releasing the sender circuit DC relay, the district junctor F relay, the operated LC relay in the district link and connector circuit and the marker AK and AK1 relays. Ground is removed from the MCB leads to the office link and connector frames.
>
> By referring to RM 5 it can be seen that the operation of the GW- and GZ- relays require the following calls to complete the cycles.
>
> Cycle of Operation GW0 and GZ0 - 2 calls
> " " " GW1 " GZ1 - 4 "
> " " " GW2 " GZ2 - 8 "
> " " " GW3 " GZ3 -12 "
>
> The GP0 relays and the GP1 relays are operated on alternate calls as described above while the marker circuit is testing the outgoing trunks. These relays perform no useful function on calls for trunk groups which are not subdivided. However, on calls for trunk groups which are divided

into two or three subgroups, the ST, TL, GS and GE punchings of the route relay are not cross-connected directly to the required points, but are connected to a set of correspondingly designated GC punchings at the GPO relays and also at the GP1 relays. The corresponding GP punchings at the GP-OA or GP-OB relays are cross-connected to the start, trunk level, group start and group end points for one of the subgroups of trunks, and the GP punchings at the GP-1A or GP-1B relay are cross-connected to the required points for the second subgroup of trunks.

Trunk groups divided into two subgroups have only one route relay. With the above circuit arrangement, calls for such trunk groups are distributed over both subgroups, using one route relay. This applies to original routes in ground supply groups No. 1 and No. 3, to alternate routes in ground supply group No. 3, and is also used with overflow and permanent signal trunk groups in ground supply group No. 5 if they consist of two subgroups.

Trunk groups divided into three subgroups have two route relays located in ground supply groups No. 1 and No. 2, or in ground supply groups No. 3 and No. 4. In either case, the first route relay of the two, located in group No. 1 or No. 3, has associated with it two of the three subgroups of trunks, successive calls being distributed over them as described above for a trunk group divided into two subgroups. The second route relay, located in ground supply group No. 2 or No. 4, has associated with it the third or common subgroup of trunks.

The marker circuit is arranged so that for trunk groups divided into two subgroups, both subgroups are tested under trunks busy conditions. For trunk groups divided into three subgroups, if the first one tested is found busy, the next attempt can be made on the other subgroup or it can be made on the common subgroup associated with the second route relay.

Relays GP-OA and GP-OB or GP-1A and GP-1B, whichever were operated, release.

Release of the operated GP- relays as above removes ground from the ST, TL, GS and GE cross-connections for these relays. This releases the office and district frames, and the operated trunk level, group start and group end relays. The marker O and PA relays and the SPE and SPO or NSE and NSO relays, whichever were operated, release due to the release of the office frames.

Marker circuit PT and TBL relays release and the GT3 relay operates and locks.

Marker circuit GZO relay operates, if normal, or it releases, if operated, and the GT1 and GT2 relays release.

The DC lead to the marker connector is closed in part to the DK lead to the district link and connector circuit.

> Ground is connected to the even and odd MCB leads to the office link and connector frames. The operating path of the SR relay is closed in part.

Marker circuit GP-1A and GP-1B or relays GP-OA and GP-OB operate.

> The relays to operate at this time are the ones that were normal at the beginning of the call, the change from one pair to the other having been accomplished by the operation or release of the GZO relay.
>
> The ST, TL, GS and GE punchings at the operated route relay are now closed through the operated GP relays to the required points for connection of the other subgroup of trunks to the marker. The office and district frames function as before, and the call proceeds in the regular manner, provided that an idle trunk is found in this subgroup. The SP and GT3 relays release when the operated route relay releases on disconnection.

BOTH SUBGROUPS BUSY - OS 325, OS 331

If, under the conditions described in the preceding paragraph, all the trunks in the second or mate subgroup tested are found busy, the call is routed to the overflow trunk group.

When the PT relay operates for testing the second subgroup, the TBL relay operates under the assumed condition that all these trunks also are busy. It operates the TB relay because of the GT1 relay now being released. Operation of the TB relay removes ground from the SP punching of the route relay, releasing the SP and GT3 relays. The call is then routed to overflow or reorder as described for an all trunks busy condition in a trunk group not subdivided.

TRUNK GROUPS DIVIDED INTO THREE SUBGROUPS

ONE SUBGROUP BUSY - OS 310, OS 311, OS 317, OS 325, OS 331

In this case, for an original route having no alternate route, the first choice route relay associated with two of the subgroups is in ground supply group No. 3. The second choice route relay associated with the third or common subgroup is in ground supply group No. 4.

Trunk groups subdivided in this manner are arranged for the distribution of successive calls over the two subgroups associated with the first choice route relay. The first choice route relay will have its SP punching connected to the SPB punching to enable the marker to test the second subgroup, if the first one tested is busy, before advancing to the next ground supply. Consequently, the first original route relay in ground supply group No. 3 has its other punchings connected as required, and its RA punching to RC at the common original route relay in ground supply group No. 4.

The second original route relay has its OB, OG, CL and CR punchings cross-connected to correspond with the first choice route relay as the information required by the sender is the same for all the trunks of the group. The RA punching of the second original route relay is cross-connected to the RC punching of the required overflow route relay in ground supply group No. 5. The ST, TL, GS and GE punchings are cross-connected to correspond with the location of the common subgroup of trunks.

On routes of this type the transmission or charge relay is connected in series with the first choice relay, as described for a regular call. As this relay remains operated and there is no necessity to change this information in progressing from the first choice route relay to the second, the R punching of the second choice route relay is connected to battery at the ZAR punching.

In this case, assuming that all the trunks in both subgroups tested are found busy, the TBL relay operates and the circuit advances as described for all trunks busy in a trunk group not subdivided, except that the overflow register does not score and the release of the TB3 relay causes the second choice route relay in ground supply group No. 4 to operate. Operation of this relay connects battery to the ST punching and ground to the TL, GS and GE punchings corresponding with the common subgroup of trunks, causing these trunks to be connected to the marker for test. The sender register relays released by operation of the TBL relay are reoperated in the same pattern.

The circuit advances from this point as described for a regular call, assuming that an idle trunk is found in the common subgroup. The G3 and GS3 relays release when the ST5 relay operates.

COMMON SUBGROUP BUSY

If, under the conditions described in the preceding paragraph, all the trunks in the common subgroup are found busy, the TBL relay operates and the call is routed to the overflow trunk group. The sequence of operation is as described for an all trunks busy condition in a trunk group not subdivided, except that the TB4, G4 and GS4 relays are used instead of the TB3, G3 and GS3 relays, respectively. Release of the TB4 relay causes the required overflow route relay and the OV relay, or the KP relay if required, to operate and the call continues as described for the selection of an overflow trunk or the return of a reorder signal.

TRUNKS BUSY CONDITIONS

OS 310, OS 311, OS 318, OS 325, OS 331

ON ORIGINAL ROUTES HAVING TANDEM ALTERNATE ROUTES

In the preceding paragraphs, trunks busy conditions with relationship to subgrouping was described on the basis of original routes having no alternate routes and were in ground supply groups No. 3 and No. 4.

These same conditions as applied to these original routes in ground supply groups No. 3 and No. 4 can be duplicated for original routes in ground supply groups No. 1 or No. 2 having a tandem alternate route in one or more of the ground supply groups Nos. 2, 3 and 4.

The only exception to the preceding paragraphs is that progression will not be immediately to the overflow trunk group upon finding all trunks busy in the original route, but rather to the alternate route or routes.

When trunks busy conditions are encountered in ground supply groups No. 1 and No. 2, the No. 1 and No. 2 TB-, G- and GS- relays are used.

As described for original routes in ground supply groups No. 3 and No. 4, both subgroups of trunks are tested if the trunk group is divided into two subgroups. In this case, and for trunk groups not subdivided, there is no common original route relay and the next attempt is made on the alternate route trunks. If the trunk group is divided into three subgroups, one or two of those associated with the first route relay is tested, then the common subgroup associated with the second choice route relay, and then, if necessary, an attempt is made on the alternate route trunks.

ON TANDEM ALTERNATE ROUTES - OS 310, OS 311, OS 325, OS 318, OS 331

First, second and third choice tandem alternate route relays are located in ground supply groups Nos. 2, 3 or 4, the route relays for their original routes being located in ground supply groups No. 1 and No. 2, or in No. 1 only.

Trunks busy conditions for alternate routes appearing in ground supply groups No. 3 and No. 4 are subjected to the same conditions as already described in the preceding paragraphs for an original route and its subgrouping in ground supply groups No. 3 and No. 4.

An alternate route appearing in ground supply group No. 2 may or may not be limited to testing of one subgroup if the trunk group was divided into two or more subgroups. To illustrate this point, assume that a destination could be reached by one original and three alternate routes, each containing 80 trunks. This would require eight subgroups, plus the overflow group. If the marker tested all eight trunk subgroups in peak traffic before testing the overflow trunks, the excessive testing would affect marker holding time adversely. Nevertheless, in some locations this abnormal condition is used.

The R punching of each first, second and third alternate route relay is connected to battery at the ZAR punching as the transmission or charge relay connected in series with the original route relay remains operated and there is no occasion to change this information when progressing to an alternate route.

2-WIRE AND CROSSBAR TANDEM ALTERNATE ROUTES

OS 318

The route relays for 2-wire office and crossbar tandem alternate routes are usually located in ground supply group No. 2. The cross-connections on these relays and the action of the circuit with respect to them are the same as for tandem alternate routes, except that provisions are made to obtain the office brush and group, the class of call and compensating resistance information for the alternate route from the original route relay. This arrangement reduces the number of alternate route relays required for a group of original routes using the same alternate route of this type.

On routings of this kind, the class of call is necessarily the same for a given code when using the alternate route or the original route, but may vary for different codes using the common alternate. Consequently, the class of call information is obtained from the original route relay whether the original or the alternate route is used.

On these routes the compensating resistance information to be transmitted to the sender for the alternate route, which includes office compensating resistance, beyond office compensating resistance and trunk guard relay information is obtained from the original route relay, the SB punching of which is cross-connected as required.

The office compensating resistance in this case, for calls through one 2-wire office center, is the same regardless of the destination to which the call is to be completed. The beyond office compensating resistance, however, may be 0, 300, 600 or 900 ohms, for different terminating offices, and with each of these values either the TG relay or the MTG relay may be used. Unlike the class information, the compensating resistance information is not necessarily the same for the alternate route as for the original route and therefore the SB punching is used to derive this from the original route relay.

For the selection of individual trunk groups to different destinations so reached from the 2-wire office center, different combinations of office brush and office group information must be provided for each code.

This is done by cross-connecting the OB and OG punchings of the original route relay in accordance with the requirements of the 2-wire or crossbar tandem alternate route for that code, and to cause the sender to skip office selections when the original route is used. To skip office selections under these conditions the SP punching of the original route relay is cross-connected to the OG-5-S or P punching, because if the original route trunks are subdivided, one or two groups can be tested. The SG punching is also cross-connected and is used to indicate high or low five office brush selection.

The SP punching, when cross connected in this manner, causes the OG5 relay to operate and ground the SO lead to the sender. The SP punching does not connect ground to the OG punching at the operated route relay. The OG cross-connection, consequently, is not effective with respect to the original route, and with only one punching grounded in the OG transmitting relay group, there is no interference with the check of the transmitting leads and the operation of the TK relay.

The OB punching is effective, however, with respect to the transmission to the sender of the office brushrequirement for the alternate route, but does not cause the sender to make office brush selection as it has received in addition the skip office information. The sender is arranged so that it will function satisfactorily with office group relays operated, if the SO relay is also operated, as in this case it passes by the selection even though it is set up. The transmission to the sender of the office brush information is necessary so that the check of the transmitting leads may be completed and the TK relay operated.

In order to provide the office selection compensating resistance and class of call information for the alternate route on this basis, the OB, OG, SG, SB, CR and CL punchings of the alternate route relay are not cross-connected, the SP punching, however, is connected to the TWB punching. Though there may be two subgroups of trunks associated with this particular type of alternate route, the marker cannot be made to test them both. The addition of "CG" wiring to the markers eliminates the feature of the TWA punching that makes it possible to test both subgroups of a 2-wire or crossbar tandem alternate route. If this alternate route relay is in ground supply No. 3 or No. 4 it also will be necessary to cross-connect the SG punching to the SPB punching to provide ground supply for the OB, OG and SB punchings on second trial calls.

On a marker call for a destination having a 2-wire alternate, the original route relay operates and records in the sender the skip office from the SP punching, class of call from the CL punching and compensating resistance with TG or MTG information from the CR punching.

Testing of the original route trunks takes place in the usual manner. If an idle trunk is found the call completes as described for a regular call. Should all trunks be busy the TBL relay operates followed by TB, TB1, G1 and GS1 relays. This causes the recorded sender information to be released and the district and office link frames to disconnect, releasing the TBL, TB and TB1 relays.

The release of the TB1 relay with the G1 relay operated grounds the original route relay RA punching, which operates the 2-wire alternate route relay.

The TWA relay is operated from the SP punching. The TWA relay operated releases the GS1 relay, previously operated due to the trunks busy condition, and connects ground to the contacts of the GS1 relay that are used with the

OG and SB punchings of the original route relay. The TWA relay also connects ground through a check relay to the TW lead to the sender, as an indication of the need for the sender to allow more time to complete the call.

Under these conditions the OB, OG, SG, SB and CL punchings of the original route relay are grounded. The SP and CR punchings of the original route relay are not grounded because the G1 relay is not released. This causes the required office selection compensating resistance and class information to be returned to the sender without interference, as the OB, OG, CR and CL punchings of the alternate route relay are not cross-connected. From here on the call functions as already described for alternate routings.

2-wire alternate routes having 2-wire original routes require one or two route relays, depending upon the size of the office selector trunk group, for each destination reached through the 2-wire office center, as in this case the OB and OG punchings of the original route relay are required for the original route and cannot be used for the alternate route. The SP punchings of both the original and the alternate route relays in this case are connected to the SPA or the SPB punching.

PEG COUNT AND OVERFLOW REGISTERS

PC PUNCHING - OS 315

The PC punching is provided from the route relays to furnish means for operating a message register and thus record the number of calls routed to a particular trunk group.

On trunk groups to the same destination that have two route relays the PC punching of only the first choice route relays shall be cross-connected. The PC punching of the second choice will not be cross-connected because if they were then the register would be operated twice for one call whenever the second choice route relay was operated.

The path for operating the register is wired through the contacts of the SM relay to prevent its possible false operation if there is a second call waiting in the decoded stage as the marker releases at the end of the first call.

The GT1 or GT3 relay when operated provides a locking path for the JD relay preventing its release when all trunks are found busy in the first subgroup on a route having two subgroups. This is to prevent double operation of the PC register.

OF PUNCHING - OS 315

The OF punching is provided from the route relays to furnish means for operating a message register and thus record the number of times that all trunks of the group are found busy.

On trunk groups that have two route relays of the OF punching of the second choice route relay will be cross-connected to the required register, while the OF punching of the first choice route relay will not be connected.

The ground lead to both the PC and OF punchings is opened at the contacts of the DMT relay when marker test calls are made so that these registers will not be operated. On sender test calls the JD relay does not operate and therefore the circuit is not closed to these registers.

PERMANENT SIGNAL - OS 312, OS 316

If a sender is selected and dialing does not take place, due to a permanent signal or a trouble condition, the call is routed to a permanent signal holding trunk originating at the office link secondary switches. In this case the sender counts time and then connects to a marker through a marker connector circuit, as for a regular call. It connects ground to the A1 and A4 receiving leads as an indication of the permanent signal condition, records in the marker the class of service and district frame information as before, but does not connect the receiving leads for the B and C digits to ground or to check leads.

On a call of this type the marker functions as for a regular call, except that the B and C recording relays and the CK2, CK5, TN and H relays do not operate and ground is connected to the PS code point (at the A5 relay) when the CK1 relay releases.

One route relay is provided for each class of permanent signal trunks, such as coin and noncoin, these relays being located in ground supply group No. 5. Charge and station delay conditions do not affect the number of permanent signal route relays as an operator talking condition is required in all cases and as the sender has timed out, the subscriber is not expected to dial. The number of trunks in the trunk group for any one class does not affect the number of route relays, as the marker does not progress from one ground supply group to another in an attempt to find an idle permanent signal trunk.

The PS code point is cross-connected, if there are two or more classes of permanent signal trunks, through contacts of the service relays to the RC punchings of the route relays for the respective classes. If there is only one class of permanent signal trunks, the PS code point is cross-connected directly to the RC punching of the route relay, the R punchings of permanent signal route relays are connected to the Z punching at the PS relay.

The SP and RA punchings of permanent signal route relays are not cross-connected. The OB, OG, SG, CL and CR punchings are cross-connected, except that the OG punching is cross-connected to OG-5S for one subgroup and to OG-5B for two subgroups. The TL, GS, GE and ST punchings are cross-connected directly for a trunk group not subdivided, or to contacts of the GP relays if there are two subgroups.

When the PS code point is grounded the permanent signal R relay and the PS relay operate in series followed by the operation of the PS1 relay.

The PS1 relay closes a circuit, short-circuiting the top No. 1 and No. 2 contacts of the TB relay, through which ground is connected to the transmitting leads to the sender, so that in case of an all trunks busy condition where the TB relay operates, the sender register relays will not be released. It also connects an additional locking circuit for the AK and AK1 relays supplementing the top contacts of the TB relay.

The marker circuit OT1 and PS2 relays operate.

Due to operation of the route relay, the selection of a trunk, the release of the sender, and the selection of a channel take place as before. The district junctor is set for operator talking as follows:

Ground is connected to the OT lead to the district link and connector circuit. Then the AC and PS2 relays release in the marker and ground is removed from the OT lead.

The PS2 relay is slow release to allow time for the district junctor circuit to record the operator talking condition before ground is removed from the OT lead.

Marker circuit TCK relay operates.

Operation of the TCK relay indicates that the operator talking condition has been properly recorded by the district junctor circuit.

The marker circuit advances from this point and restores to normal as described for a regular call.

ALL PERMANENT SIGNAL TRUNKS BUSY - OS 310, OS 311, OS 331

If a permanent signal trunk group is divided into two subgroups and the first one tested is found busy, the other subgroup is tested due to the OG cross-connection being made to the OG-5P punching. If all the trunks of the group are found busy, whether it is subdivided or not, the circuit advances as described for all overflow trunks busy, except that operation of the TB5 relay causes the DL relay to operate for calling in the trouble indicator, if that circuit is available, as indicated by the TIB relay normal.

The trouble indicator is used in thses cases to assist in locating a subscriber's lines that have permanent signals which have not been set up to permanent signal trunks due to an all trunks busy condition or an all channels busy condition. When the trouble indicator has obtained a record of the condition, the TIB relay is operated.

If the trouble indicator circuit is busy, the marker circuit TIB relay will have been operated. In this case the DL relay cannot operate and operation of the TB relay connects ground to the PS lead to the district link and connector circuit.

Ground on this lead is closed through the operated MCB relay in the district link and connector circuit for operating a PS relay (not shown) in the district link frame circuit. The PS relay locks and provides audible and visible alarms at the district frame to which the calling line is connected.

Whether the trouble indicator is idle or busy the marker finally grounds the RO lead should the condition be all permanent signal trunks busy. If an idle permanent signal trunk is selected followed by an all channels busy condition the TRL lead is grounded. The sender, however, does not make any additional trials, but instead will cause the district junctor to cut through even though there is no trunk attached and then the sender will restore to normal. The district junctor will hold until the calling subscriber disconnects.

TROUBLE DETECTING RELAYS

MARKER NORMAL

During the periods that the marker is normal, the trouble detecting relays as listed below are connected through the normal contacts of the STX and RX relays to leads of associated frames for the purpose of detecting crosses, off-normal and foreign ground conditions.

At the beginning of a call, the marker DA2 relay releases and operates the STX and RX relays. This disconnects these trouble relays during the progress of a call. The RX relay will be released when the CK6 relay releases, but will again operate when the AK relay releases, so that associated trouble relays are disconnected while the office link and district link release.

Should any one of the relays on the attached chart operate, except the XX1 relay, it will cause the XX2 or DL relay to operate.

Detecting Relay		Leads & Relays Protected			Operated Control Relay
		Off. Lk.	Dist. Lk.	Marker	
XCH	(STX)	LS Leads	S Leads LS "	AB Relays C "	XX2
XDC				DC Lead	XX2
XDF1	(STX)	SB Leads		DF Relays	DL
XK	(STX)	PSA Leads PSB " SSA " SSB "	SSA Leads SSB "		XX2
XK1	(STX)	CK Lead		CK Relay NSE " NSO " SPE " SPO "	XX2
XRL (MG)	(RX)		TRL Lead	TRL Lead RL " RO "	DL
XS1	(STX)	S1 Leads		T Relays	XX2
XSL			SL Lead		XX2
XSM	(RX)	SMR Leads SML "			XX2
XTC	(RX)		TC Lead OT " TP "		XX2
XTL1	(RX)	TL0 to TL4 Leads			XX2
XTL2	(RX)	TL5 to TL9 Leads			XX2
XTL3	(RX)	TL10 to TL14 Leads			XX2
XX1	(STX)		MR Lead	MR Relay	
XZ	(RX)		ZA to ZJ Leads		XX2
XZS	(RX)		ZS Lead		XX2

The XX2 relay when operated opens the LS leads to the district and office link frames, opens the BK lead, opens the RL lead and the operating path of the MRL relay, holds the marker busy and connects ground to the time measure circuit, if not already in operation and operates the DL relay. It also closes a locking circuit for the XTL1, XTL2 and XTL3 relays, if operated.

When the DL relay operates, it connects ground to the TIA lead to the trouble indicator frame and operates the TR relay. The TR relay calls in the trouble indicator circuit.

Should the XRL operate, it locks, connects ground to start the time measure if not already in operation and locks in the operated DF- relay. The DF- relay is locked for the purpose of retaining the district frame number in case the ground which operated the XRL relay also causes the sender to disconnect from the marker. Only the secondary winding of the XRL relay is marginal. This is to prevent a false XRL on recording a third trial in the subscriber sender because of a resistance feedback from the TR3 and TR4 relays.

If the MR relay should be operated with the STX relay normal, which would occur if the MR or MR1 lead should be falsely grounded with the marker idle, it would operate the XX1 relay. In this way the MR relay acts as its own trouble detecting relay.

The XDF1 relay checks for short-circuits on the contacts of the DF0 to 19. Such a short circuit might cause seizure of an unwanted district link frame when the desired district link frame is busy. This would result in the grounding of the DC lead and false operation of the F- and LC- relays and select magnets on busy district frame.

DURING DECODING STAGE

The OB, OG, SG, CR and CL numbered transmitting relays have marginal trouble detecting relays (XOB, XOG, etc.) connected in series with their windings. These relays do not operate under normal conditions. However, if a false ground or a cross should occur, causing any two windings of the numbered transmitting relays of a group to be energized, the associated X relay would operate, in turn operating the XX1 relay.

The transmitting leads are connected through normal contacts of the numbered transmitting relays to the windings of the XT and XT1 relays. A false ground on any of these leads with the circuit normal, or a false ground on a lead not used during a call or a short-circuit between a lead used for a call and one not used, consequently causes the XT or the XT1 relay to operate. Either of these relays operated operates the XT2 relay, which in turn operates the XX1 relay.

If the XX1 relay operates due to closure of any of the paths described, it locks, connects ground to operate or hold the CBR, CBS and CBT relays, connects ground to start the time measure if not already in operation, and opens the RL lead to the marker connector.

If the marker is busy in service, the call is blocked. The RL lead being opened prevents the transmission of a regular release signal if one has not already been given. Whether in service or not, the closure of ground to the CBR, CBS and CBT relays and to the time measure relays insures that the marker circuit is held busy and that it times out. This operates the trouble alarm and calls in the trouble indicator for a record.

The following chart associates the trouble detecting relays with their protection for this group.

Detecting Relay		Leads & Relays Protected Leads	 Relays	Operated Control Relay
XOB	(MG)		OBP & OBS OBO to OB9	XX1
XOG	(MG)		OGP & OGS OGO to OG5	XX1
XCR	(MG)		CRP & CRS CRO to CR9	XX1
XCL	(MG)		CLP & CLS CLO to CL5	XX1
XSG	(MG)		SGO & SG1	XX1
XT		SD & SD1 SO & SSO OB1,2,4 OG1,2,4,5		XT2 & XX1
XT1		CR1 to 5 CL1 to 5 TW		XT2 & XX1

DURING MARKER STAGE

During the progress of the marker stage operation there are X relays which protect important leads, also those that are associated with groups of relays where a selection of one relay is made.

Those X relays that are associated with groups of relays supply the battery feed to the windings and are marginal. If more than one relay in a group operates, the associated X relay operates, in turn operating either the XX2 or DL relay.

The following chart associates the trouble detecting relays with their protection for this group.

Detecting Relay		Leads & Relays Protected Off. Lk.	Dist. Lk.	Marker	Operated Control Relay
XC	(MG)			ZA1 to ZJ1 Relays TC1 Relay OT1 " KP1 "	XX2
XDC				DC Lead	XX2
XDF	(MG)			DF0 to 9 Relays	DL
XGE	(MG)			GRP. END. TG0 to 9 Relays	XX2
XGS	(MG)			GRP. START TG0 to 9 Relays	XX2
XLC		EVEN FR. LC0 to 9 Relays		EVEN FR. LC0 to 9 Leads	XX2
XLC1		ODD FR. LC0 to 9 Relays		ODD FR. LC0 to 9 Leads	XX2
XOF	(MG)	OK Lead		0-0 to 9 Relays	XX2
XRL	(MG)		TRL Lead	TRL Lead RL " RO "	DL
XS		S Lead			XX2
XSM1	(MG)		B Lead		XSM2 & DL
XSS	(MG)	SS0 to 9 Relays			XX2
XTC			TC Lead OT " TP "		XX2
XTL	(MG)			TL0 to 14 Relays	XX2
XG			ZA to ZJ Leads		XX2

CHAPTER 5

SECTION 5

MISCELLANEOUS INFORMATION AND FEATURES

Originating Marker Circuit	SD-25016-01
District Link and Connector Circuit	SD-25031-01
Office Link and Connector Circuit	SD-25033-01

MARCH 1954

OFFICE JUNCTOR PATTERNS

OS 340

The distribution of office junctors is such that the office junctors on a district frame are always equally divided over all the office frames. The maximum number of junctors available between any district and any office frame is therefore obtained by dividing 200 by the number of office frames.

The junctor patterns laid out in new offices are arranged to provide for the addition, at some later time, of two district and office link frames. For example, an original installation may only consist of 6 district and 6 office frames; however, its junctor patterns are laid out for an 8 district and 8 office frame central office. This plan makes it possible to add 2 district and 2 office frames without necessitating an office junctor rearrangement which in a working office presents a major problem.

The following charts indicate the junctor distribution the patterns and choices required for the different sizes of jobs.

No. of Frames	Max. No. of Junctors	No. of Junctors Used	No. of Junctors in Test Choice				
			A	B	C	D	E
Arrangement before Additions							
2	100	60	20	20	20*	20**	20
4	50	30	20	20*	20*	20*	10
6	33	25	20	20*	20*	20*	5
8	25	20	20				
10	20	16	16				
12	16	14	14				
14	14	12	12				
16	12	12	12				
18	11	11	11				
20	10	10	10				
Arrangement after Additions							
4	50	40	20	20*	20*	20*	20
6	33	30	20	20*	20*	20*	10
8	25	25	20	20*	20*	20*	5
10	20	20	20				
12	16	16	16				
14	14	14	14				
16	12	12	12				
18	11	11	11				
20	10	10	10				

Arrangement before Additions:

* Same junctors as A test choice

** Same junctors as B test choice

Arrangement after Additions:

* Same junctors as A test choice

In those choices where there are less than 20 office junctors the pattern relays provide the necessary blanking out or make busy condition in those locations of the channel where the office junctors are not available.

On the 20 frame job and on the A E test choice of six-frame jobs the pattern relay operates directly through the contacts of the DF relay, because from a particular district frame the junctor pattern to all even office frames and to all odd office frames is the same. In all other cases when there is a pattern, the pattern relay operates through the contacts of the PA relays as well as the DF relays. This is because from a particular district frame the junctor pattern is not the same for all odd office frames and all even office frames.

Arrangement before Additions

No. of Frames	No. of Pattern Relays Required	No. of Patterns in Each Choice A	B	C	D	E
2	-	-	-	-	-	-
4	2	-	-	-	-	2
6	8	-	-	-	-	4*
8	-	-				
10	10	10				
12	10	10				
14	10	10				
16	10	10				
18	10#	10				
20	2	2				

* Two pattern relays operated in parallel for each pattern.

# One channel is blanked out by direct ground at the district link frame.

Arrangement after Additions

No. of Frames	No. of Pattern Relays Required	No. of Patterns in Each Choice A	B	C	D	E
4	-	-	-	-	-	-
6	2	-	-	-	-	2
8	8	-	-	-	-	4*
10	-	-				
12	10	10				
14	10	10				
16	10	10				
18	10#	10				
20	2	2				

* Two pattern relays operated in parallel for each pattern.

# One channel is blanked out by direct ground at the district link frame.

FOR OFFICE WITH A 20X20 JOB

On this size job there will be 10 junctors available from each district frame to each office frame. There are 2 pattern relays required because calls from even districts to even offices or odd districts to odd offices can use one pattern arrangement while calls from odd districts to even offices or even districts to odd offices will require another pattern arrangement. The first pattern relay makes busy 5, odd left channels and 5 even right channels the second relay makes busy 5, even left channels and 5, odd right channels.

FOR OFFICES WITH 10x10 JOBS OR LARGER

USE "W" WIRING IN FIG. 17 - RM 5-8

On jobs 10x10 or larger, there will be 20 junctors or less available to each office frame. The use of "W" wiring eliminates the CBA1 and CBB1 to CBA5 and CBB5 relays. On these jobs, if all channels to a particular office frame are busy, the trunk on that frame is released and the marker attempts to pick a trunk on the other frame of the pair.

The 10x10 job has 20 junctors available and consequently requires no pattern relay facilities. However, the job from 12x12 to 18x18 have less than 20 junctors to choose from (see chart) and as a result the marker requires 10 pattern relays (see chart). In addition, the 18x18 job with only 11 junctors available needs more blanking out facilities than can be provided by the ten pattern relays, so at every district frame one channel to each office frame is blanked out by connecting a direct ground to the required contacts of all JC relays on the district frame.

FOR OFFICES WITH AN 8x8 JOB

USE "Z" WIRING IN FIG. 17 - RM 5-8

The following table shows the number and arrangement of junctors in the test choices for jobs of the 8-8 variety. On jobs smaller than the 8-8 size, all of the junctors that are available are not used. In these cases the number of channels made available is sufficient to carry traffic with a reasonable amount of channel busy conditions. This method reduces the number of steps in the walking circuit from 5 to 3 and minimizes the need for pattern and pattern auxiliary relays.

No. of Frames	Max. No. of Junctors	No. of Junctors Used	No. of Junctors in Test Choice A	B	C	D	E
			Arrangement before Addition				
6	33	25	20	20*	20*	20*	5
			Arrangement after Addition				
8	25	25	20	20*	20*	20*	5

* Same junctors as A test choice

The 8-8 job after an addition makes use of 2 pattern auxiliary and 8 pattern relays to blank out the 15 unused channels when it is necessary to test the E choice.

In those choices where there are less than 20 office junctors the pattern relays provide the necessary blanking out or make busy condition in those locations of the channel test where no office junctors are available. The following table shows the PA and P relays that operate depending upon which district and office frames are being used for the call.

OFFICE FRAMES	PA RELAY OPER.		DISTRICT FRAMES							
			0	1	2	3	4	5	6	7
0	0		0-1	2-3	4-5	6-7	0-1	2-3	4-5	6-7
1	0		2-3	0-1	6-7	4-5	2-3	0-1	6-7	4-5
2	1	P	4-5	6-7	0-1	2-3	4-5	6-7	0-1	2-3
3	1	RLY'S	6-7	4-5	2-3	0-1	6-7	4-5	2-3	0-1
4	0	OPER.	0-1	2-3	4-5	6-7	0-1	2-3	4-5	6-7
5	0		2-3	0-1	6-7	4-5	2-3	0-1	6-7	4-5
6	1		4-5	6-7	0-1	2-3	4-5	6-7	0-1	2-3
7	1		6-7	4-5	2-3	0-1	6-7	4-5	2-3	0-1

FOR OFFICES WITH A 6x6 JOB

AFTER AN ADDITION

The six-six job uses 30 of the junctors available from one district link frame to each of the six office link frames and they are assigned 20 in the "A" choice and 10 "B" in the "E" or overflow choice. The junctors in the "C" and "D" choices are the same ones that appear in the "A" choice.

Successive calls will be directed to the "A" to "D" choices. If the junctors in one of these groups are all found busy, then a test is made of the "E" choice.

The CBC relay is furnished for this type of job and operates when the AC relay operates, if the marker is set for either the "A", "B" or "C" choice. Operation of the CBC relay in either one of these choices causes the call to be advanced to the "E" choice, if all junctors are found busy in the choice.

FOR OFFICES WITH A 4x4 JOB

AFTER AN ADDITION

This junctor arrangement differs from that of the 2x2 job. In this case, while 50 junctors are available from each district to each office frame only 40 junctors are used. There are 20 junctors in the "A" choice and 20 in the

"E" choice. The junctors in the "B", "C" and "D" choices are the same ones used in the "A" choice. Under normal operation the "A" to "D" choices are used on successive calls and the overflow or "E" choice is only used when the first 20 junctors are busy. The CBC relay is used on this type job and operates if the marker is set for either the A, B or C choices.

FOR OFFICES WITH A 2x2 JOB

On a two frame job the junctor choices "A" to "D" are used for normal operation, while choice "E" is reserved as the overflow choice. There are 100 available junctors to each office link frame but only 60 junctors are used. Test choices "A" and "C" contain the same 20 junctors, "B" and "D" contain a different set of 20 junctors while the "E" choice has athird set of 20 making a total of 60.

DISTRIBUTING SUCCESSIVE CALLS OVER DIFFERENT JUNCTOR CHOICES

OS 339

In periods of light traffic the marker in all probability will be able to select an idle junctor for its channel, from the existing test choice available. Fig. 17 is so arranged that at the completion of each marker call, where there has been no need for testing a second test choice of junctors, it advances the walking circuit (Fig. 17) to the next succeeding test choice. Thus, at the beginning of each call the marker is set for a different test choice of junctors. This rotation is only possible between the "A" to "D" test choices, the "E" test choice being reserved and only used when all junctors in the "A" to "D" test choices are found busy.

The JD relay controls this succession of test choices for each new call. The CBA- relay of the last test choice used and the CBB- relay for the next succeeding choice to be used, are left locked up from the previous call. When the JD relay operates, it causes the CBA- relay of the same designated as the CBB- relay already up to operate. This then releases the CBA- relay left operated from the previous call.

The operating circuit for the JD relay includes the make contacts of the TKE relay and on a normal call has no useful purpose. The purpose of this circuit is to prevent the operation of a CH- relay should a K- relay be operated falsely before the operation of the NSE or SPO relay. Should this occur the JD relay cannot operate because the TKE relay will be released. After the CHT relay operates there will be no further operation. The marker times out and calls in the trouble indicator circuit.

JC RELAY CHARTS - OS 334

FOR OFFICES WITH A 20x20 JOB

The number of the marker JC relay that is operated will always agree with the number of the office frame to which the call is going. The JC lead that is grounded to an even numbered district frame will operate a correspondingly numbered JC relay in that circuit. A grounded JC lead to an odd numbered district frame will operate a JC relay of a different number as indicated below. OS 334

MARKER JC LEAD NUMBER	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
WILL OPERATE JC RELAY ON ODD DISTRICT FRAMES	1	0	3	2	5	4	7	6	9	8	11	10	13	12	15	14	17	16	19	18

The ability to vary the district link JC relay that operates when a particular lead is grounded by the marker is the result of a cross-connection field being supplied at the district frame. This cross-connection field makes it possible for any grounded marker lead to operate any JC relay in the district link circuit. This arrangement is necessary because jobs of different sizes require different JC lead and relay combinations.

FOR OFFICES WITH 10x10 JOBS OR LARGER

The JC relays that will operate in the marker and on the district link frame for the 10x10 or larger jobs is shown on the following chart.

MARKER JC RELAY

DISTRICT JC RELAY

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
Even Dist. Fr.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17			18-18 Job
Odd Dist. Fr.	1	0	3	2	5	4	7	6	9	8	11	10	13	12	15	14	17	16			
Even Dist. Fr.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15					16-16 Job
Odd Dist. Fr.	1	0	3	2	5	4	7	6	9	8	11	10	13	12	15	14					
Even Dist. Fr.	0	1	2	3	4	5	6	7	8	9	10	11	12	13							14-14 Job
Odd Dist. Fr.	1	0	3	2	5	4	7	6	9	8	11	10	13	12							
Even Dist. Fr.	0	1	2	3	4	5	6	7	8	9	10	11									12-12 Job
Odd Dist. Fr.	1	0	3	2	5	4	7	6	9	8	11	10									
Even Dist. Fr.	0	1	2	3	4	5	6	7	8	9											10-10 Job
Odd Dist. Fr.	1	0	3	2	5	4	7	6	9	8											

FOR OFFICES WITH AN 8x8 JOB

The following table shows the marker JC relay association between particular junctor test choices and particular office frames.

8X8 JOB

MARKER JC RELAY SELECTION

OFFICE GROUP-0

	EVEN OFFICE TRUNK		ODD OFFICE TRUNK	
CHOICE	LEAD	JC RELAY	LEAD	JC RELAY
A	EA	0	OA	1
B	EB	0	OB	1
C	EC	0	OC	1
D	ED	0	OD	1
E	EE	8	OE	9

OFFICE GROUP-1

	EVEN OFFICE TRUNK		ODD OFFICE TRUNK	
CHOICE	LEAD	JC RELAY	LEAD	JC RELAY
A	EA	2	OA	3
B	EB	2	OB	3
C	EC	2	OC	3
D	ED	2	OD	3
E	EE	8	OE	9

OFFICE GROUP-2

	EVEN OFFICE TRUNK		ODD OFFICE TRUNK	
CHOICE	LEAD	JC RELAY	LEAD	JC RELAY
A	EA	4	OA	5
B	EB	4	OB	5
C	EC	4	OC	5
D	ED	4	OD	5
E	EE	9	OE	8

OFFICE GROUP-3

	EVEN OFFICE TRUNK		ODD OFFICE TRUNK	
CHOICE	LEAD	JC RELAY	LEAD	JC RELAY
A	EA	6	OA	7
B	EB	6	OB	7
C	EC	6	OC	7
D	ED	6	OD	7
E	EE	9	OE	8

FOR OFFICES WITH A 6x6 JOB

	OFFICE GROUP-0			
	EVEN OFFICE TRUNK		ODD OFFICE TRUNK	
CHOICE	LEAD	JC RELAY	LEAD	JC RELAY
A	EA	0	OA	1
B	EB	0	OB	1
C	EC	0	OC	1
D	ED	0	OD	1
E	EE	6	OE	7

	OFFICE GROUP-1			
	EVEN OFFICE TRUNK		ODD OFFICE TRUNK	
CHOICE	LEAD	JC RELAY	LEAD	JC RELAY
A	EA	2	OA	3
B	EB	2	OB	3
C	EC	2	OC	3
D	ED	2	OD	3
E	EE	8	OE	9

	OFFICE GROUP-2			
	EVEN OFFICE TRUNK		ODD OFFICE TRUNK	
CHOICE	LEAD	JC RELAY	LEAD	JC RELAY
A	EA	4	OA	5
B	EB	4	OB	5
C	EC	4	OC	5
D	ED	4	OD	5
E	EE	8	OE	9

NOTE: This job requires 2 pattern relays.

FOR OFFICES WITH A 4x4 JOB

	OFFICE GROUP-0				OFFICE GROUP-1			
	EVEN OFF. TRK.		ODD OFF. TRK.		EVEN OFF. TRK.		ODD OFF. TRK.	
Choice	Ld.	JC rel.	Ld.	JC rel.	Ld.	JC rel.	Ld.	JC rel.
A	EA	0	OA	1	EA	2	OA	3
B	EB	0	OB	1	EB	2	OB	2
C	EC	0	OC	1	EC	2	OC	3
D	ED	0	OD	1	ED	3	OD	3
E	EE	6	OE	7	EE	8	OE	9

NOTE: This job does not require pattern or pattern auxiliary relays.

FOR OFFICES WITH A 2x2 JOB

	OFFICE GROUP			
	EVEN OFFICE TRUNK		ODD OFFICE TRUNK	
Choice	Lead	JC Relay	Lead	JC Relay
A	EA	0	OA	1
B	EB	6	OB	7
C	EC	0	OC	1
D	ED	6	OD	7
E	EE	4	OE	5

NOTE: The 2x2 job does not require pattern or pattern auxiliary relays.

CHANNELS BUSY - OS 339

FOR OFFICES WITH 10x10 JOBS OR LARGER

USE "W" WIRING IN FIG. 17

On a first, second or third trial call, if an idle trunk is found but all the channels between the district junctor and the selected trunk are found busy, the marker releases the trunk and attempts to find one on the other office frame of the pair. If one is found on this frame, channel test is made a second time, and if an idle channel is found the call proceeds in the regular way.

It is assumed in this case that the call has progressed up to operation of the CHT relay, an idle trunk having been found on the even numbered office frame, and the connector having been released in the regular manner. With all channels busy, operation of the CHT relay closes a path through contacts of operated AB or C relays in the channel testing circuits causing the CHL relay to operate and battery is disconnected from the windings of the CH relays in the channel testing circuits.

> Battery is disconnected from the windings of the CH relays to prevent the selection of a wrong channel. This might otherwise occur if a channel in the group just tested and found busy should become idle, releasing its AB or C relay and causing the corresponding CH relay to operate, while the marker is advancing to select a trunk on the other office link frame of the pair.

The sequence of operations take place as indicated on SC 304 and when the PT relay again operates.

> The operation of the PT relay is condenser timed and circuit advances from this point as in a regular call, for selection of a trunk, channel test, etc., except that due to the above operations the trunks on the

office frame previously used have been made to appear busy and therefore a trunk on the other frame is selected, making it possible to select a different district frame JC relay.

If an idle trunk and channel are found, the call is completed as in regular operation.

The marker circuit CHT relay operates and the CBL, BE1, BE, CBH, JD and T relays release.

If the trunk originally selected was on the odd numbered office frame of the pair, the operation is as described above, except that the BO1, BO and the odd numbered T relays are used, and the call is transferred from the odd frame to the even frame, using corresponding equipment.

FOR OFFICES WITH AN 8x8 JOB
USE "Z" WIRING IN FIG. 17

On an eight frame job the junctor choices "A" to "D" are used for normal operation and the "E" choice is reserved as the overflow choice. Since the same 20 junctors appear in each of the groups "A" to "D", if the marker finds that all channels are busy while testing any of these choices it advances to the "E" choice where 5 extra junctors are available.

It is assumed for the description that follows that "Z" wiring is used in Fig. 17, and that the marker is set for the "A" choice junctors. In this case, the CBB1 relay was operated and locked when the JD relay released from the previous call. On the next call, the CBC relay operates after the AC relay is operated and the CBA1 operates after the JD relay.

CHANNELS BUSY - "A" CHOICE

On a first, second or third trial call, if an idle trunk is found but all channels between the district junctor and the selected trunk are found busy, the marker releases the selected JC relay by advancing the walking circuit (Fig. 17) to the "E" choice. The marker then operates the JC relay for the "E" choice junctors and channels test is made a second time, and if an idle channel is found the call proceeds in the regular way.

It is assumed in this case that the call has progressed up to operation of the CHT relay, an idle trunk having been found on the even numbered office frame and the connector has been released in the regular manner. With all channels busy, operation of the CHT relay closes a path through contacts of all operated AB or C relays in the channel testing circuit.

Marker circuit CHL relay operates and battery is disconnected from the windings of the CH relays in the channel testing circuit.

> Battery is disconnected from the windings of the CH relays to prevent the selection of a wrong channel. This might otherwise occur if a channel in the group just tested and found busy should become idle, releasing its AB or C relay and causing the corresponding CH relay to operate, while the marker is advancing to test the next choice channels.

Marker circuit CBB5 relay operates, the CBB1 and JC relays release and the district link and connector JC relay releases.

The sequence of operation takes place as indicated on SC 304 and finally the CBA5, JC and pattern relays in the marker and the JC relay in the district link and connector operate.

> The CBC relay being operated causes the circuit to advance immediately to the "E" test choice. The different JC relay being operated in the marker will cause a new JC to be operated in the district link frame and the "E" choice channels will be connected for test. The pattern relays being operated will blank out the 15 unequipped channel locations in this choice, thus permitting only 5 channels to be tested. When the BK relay operates, the CHT can operate to test for an idle channel.

CHANNELS BUSY - B, C OR D CHOICES

On successive calls these choices are tested in order, the channels in them are the same as those in the "A" choice. Consequently, with a channels busy condition in any of these choices, the operated CBB relay will cause the circuit to advance to the "E" choice.

CHANNELS BUSY - "E" CHOICE

If all channels in the "E" choice are found busy the CHT and the CHL relays in the marker operate.

The sequence of operation takes place as indicated on SC 304 and finally the TKE and PT relays operate.

> The operation of the PT relay is condenser timed and the circuit advances from this point as in a regular call, for selection of a trunk, channel test, etc., except that due to the above operations the trunks on the office frame previously used have been made to appear busy and therefore a trunk on the other frame is selected. Transferring over to the other office frame provides a new selection of JC relays and office junctors in each of the "A" and "E" choices.
>
> If an idle trunk and channel are found, the call is completed as in regular operation.
>
> If the trunk originally selected was on the odd numbered office frame of the pair, the operation is as described above, except that the BO1, BO and the odd numbered T relays are used, and the call is transferred from the odd frame to the even frame, using corresponding equipment.

If an idle channel cannot be found in the "A" choice on this second cycle, the circuit operation repeats as described under "Channels Busy - "A" Choice", advancing to the "E" choice. During this period, the BE1, BE and CBH relays remain operated.

CHANNELS BUSY - "E" CHOICE SECOND CYCLE

Should all channels be found busy in the "E" choice on the second cycle of test, all possible office junctors for this call will have been exhausted. The operation of the CHL relay under this conditions causes the marker circuit CRL and RL1 relays to operate, causing ground to be connected to the TRL lead.

On first and second trial calls the ground connected to the TRL lead is extended through the district link circuit, the district junctor and sender link to the sender. This causes the sender to make another trial. On third trial calls the sender causes the district junctor to be closed through without a channel connected.

Marker circuit RL relay operates.

The RL relay is made slow operate to insure the operation of the sender relay before ground is removed from the TRL lead.

Marker circuit MRL operates.

From this point the marker returns to normal as described for a regular call.

FOR OFFICES WITH A 2x2 JOB
USE "Z" WIRING FIG. 17

On a two frame job the junctor choices "A" to "D" are used for normal operation but the "E" choice is only used for overflow. The same 20 junctors are contained in choices "A" and "C" and a different set of 20 junctors are contained in choices "B" and "D" while the "E" choice has a third set of 20 junctors.

It is assumed that "Z" wiring is used in Fig. 17 and that the marker is set for the "A" choice of junctors with the CBB1 relay operated and locked from the last call, the CBA1 relay operates when the JD relay operates on the next call.

CHANNELS BUSY - "A" CHOICE

On a first, second or third trial call, if an idle trunk is found but all channels between the district junctor and the selected trunk are found busy, the marker releases the selected JC relay by advancing the walking circuit (Fig. 17) to the next choice. The marker then operates the JC relay for the next choice junctors and channels test is made a second time, and if an idle channel is found the call proceeds in the regular way.

It is assumed in this case that the call has progressed up to operation of the CHT relay, an idle trunk having been found on the even numbered office frame and the connector has been released in the regular manner. With all channels busy operation of the CHT relay closes a path through contacts of all operated AB or C relays in the channel testing circuit.

Marker circuit CHL relay operates and locks and battery is disconnected from the windings of the CH relays in the channel testing circuit.

> Battery is disconnected from the windings of the CH relays to prevent the selection of a wrong channel. This might otherwise occur if a channel in the group just tested and found busy should become idle, releasing its AB or C relay and causing the corresponding CH relay to operate, while the marker is advancing to test the next choice channels.

Marker circuit CBB2 relay operates, the CBB1 and JC relays release and the district link and connector JC relay releases.

The sequence of operation continues as indicated on SC 304 to the operation of the district link and connector circuit JC relay.

> With the JC relay operated, the "B" test choice of junctors are now connected and the BK relay again operates removing the shunt from the winding of the CHT relay, which starts to operate to test for an idle channel.
>
> The above operations will also apply to channels busy in the "C" choice and cause the circuit to walk to the "D" choice.

CHANNELS BUSY - "B" OR "D" CHOICES

If all the channels in the "B" or "D" test choices are also found busy, then when the CHL relay again operates for each test choice the CBB2 and CBA2, or CBB4 and CBA4 and the CBB5 and CBA5 relays are operated in their order as described for the "Channels Busy - "A" Choice", advancing to the "E" test choice. The CBC relay operating when the CBB2 relay operates causes the "C" and "D" choices to be passed without testing.

CHANNELS BUSY - "E" CHOICE

If all channels in the "E" choice are found busy the CHT and CHL relays in the marker again operate.

> Battery is disconnected from the windings of the CH relays in the channel testing circuits.

The sequence of operations continues as indicated on SC 304 to the operation of the marker TKE and PT relays.

The operation of the PT relay is condenser timed and the circuit advances from this point as in a regular call, for selection of a trunk, channel test, etc., except that due to the above operations the trunks on the office frame previously used have been made to appear busy and therefore a trunk on the other frame is selected. Transferring over to the other office frame provides a new selection of JC relays and office junctors in the "A" to "E" choices.

If an idle trunk and channel are found, the call is completed as in regular operation.

If the trunk originally selected was on the odd numbered office frame of the pair, the operation is as described above, except that the BO1, BO and the odd numbered T relays are used, and the call is transferred from the odd frame to the even frame, using corresponding equipment.

If an idle channel cannot be found in the "A" choice on this second cycle, the circuit operation repeats as described under "Channels Busy - "A" Choice", advancing to the "B" choice and then if necessary to the "E" choice. During this period the BE1, BE and CBH relays remain operated.

CHANNELS BUSY - "E" CHOICE SECOND CYCLE

Should all channels be found busy in the "E" choice on the second cycle of test, all possible office junctors for this call will have been exhausted. The operation of the CHL relay under this condition causes marker circuit CRL and RL1 relays to operate, causing ground to be connected to the TRL lead.

On first and second trial calls the ground connected to the TRL lead is extended through the district link circuit, the district junctor and sender link to the sender. This causes the sender to make another trial. On third trial calls the sender causes the district junctor to be closed through without a channel connected.

Marker circuit RL relay operates.

The RL relay is made slow operate to insure the operation of the sender relay before ground is removed from the TRL lead.

Marker circuit MRL relay operates.

From this point the marker returns to normal as described for a regular call.

ALL TRUNKS BUSY ON SECOND TEST - SC 305

On first and second trial calls if all channels are found busy and if on the second test all trunks are found busy on the remaining frame, a trouble release signal is sent to the sender. This signal is sent by way of the district junctor and sender link and causes the sender to make another trial. In this case a regular release signal has already been sent to the sender, so that it is impossible for the marker to progress to a second choice or alternate route relays on the same trial.

On third trial under these conditions the sender restores to normal upon receiving a trouble release signal.

The marker circuit TBL and CRL relays operate.

> Ground is connected to the OF punchings at the operated O- relay. These punchings are cross-connected to office overflow registers.

The RL1 relay operates and connects ground to the TRL lead.

> The TRL lead ground is connected through the district link and connector circuit, and is extended through the district junctor and sender link to the sender. This causes the sender to make another trial or to release on a third trial call.

As indicated on SC 305, the circuit advances to the operation of the MRL relay causing the marker circuit to restore to normal.

FAILURE OF SPE, SPO, NSE OR NSO RELAYS

SC 306, OS 327

If any one of relays SPE, SPO, NSE or NSO fails to operate on a first trial call in which it is required, the PT relay is prevented from operating. This causes the marker to time out, call in the trouble indicator and send a trouble release signal to the sender. The sender then makes a second trial, causing the BF, AR1 and AR2 relays in the marker to operate.

If the trouble also occurs on the second trial, the trunks on the office frame that failed to check in are caused to appear busy so that a trunk on the other frame may be selected. This is accomplished as follows, assuming that one of the even frame relays failed to operate, due to a trouble in the office frame or in the lead between the office frame and the marker.

Marker circuit XBE or XBO relay operates depending upon which one of SPE, SPO, NSE or NSO relays failed to operate in turn causing the BF relay to release.

> The BF relay is slow release so that on second and third trial calls it will not have time to release falsely, if there is a difference in time between the operation of the NSE or SPE relays and the NSO or SPO relays. This may be expected, due to a difference in the time where the TL and TR relays on one office link frame operate sooner than the TL and TR relays on its mate frame. On second and third trial calls then the XBE or XBO relays may normally be expected to operate momentarily, but they will release before the BF relay has time to release.

Marker circuit BE or BO relay operates causing all even numbered or all odd numbered T relays to operate.

> This makes all the trunks on the frame that failed to check in appear busy so that they will not be selected.

The SPE, SPO, NSE or NSO relay that failed, operates followed by the operation of the PT relay.

The circuit advances from this point as in a regular call, if the even numbered T relays are operated, then the odd numbered trunks are available for selection, if the odd numbered T relays are operated, then the even numbered trunks are available for selection.

The XBE or the XBO relay, whichever is used, releases when the ST1 relay releases. The BE or the BO relay, whichever is used, releases when the AR2 relay releases. Release of the BE or BO relay causes the corresponding T relays to release.

If a failure such as the above occurs due to a trouble in the relay itself or in the wiring in the marker, and the relay consequently does not operate at all, the marker times out and calls in the trouble indicator again, as on a first trial. A stuck circuit is also caused if, due to trouble conditions, three or all four of these relays should operate, as in such a case the PT relay cannot operate.

TIMING CIRCUIT - SC 303, OS 341

The TM interrupter and the timing relays TMS, TMS1, TMS2, TMW, TMZ, TM1, TM4 to TM 7 and TM10 are provided for calling in the trouble indicator and releasing the marker and associated circuits, if the progress of the circuit should be stopped due to trouble.

The short time-out is divided into three stages. The first stage covers the period from seizure of the marker circuit to the completion of registration of the code, district frame and class of service information. The time allowed for these functions is from approximately .535 seconds minimum to 1.595 seconds maximum, depending upon the position of the interrupter at the time the circuit is seized.

If no trouble is encountereddduring the first stage, the timing operations are continued, an additional 3.18 seconds being allowed for the circuit to progress up to operation of the DK relay. This constitutes the second stage, the total time being 3.715 seconds minimum to 4.775 seconds maximum.

When the DK relay operates, any remaining time for the second stage is cancelled and the third stage is started. A period of approximately 1.595 seconds minimum to 2.655 seconds maximum is allowed for the circuit to complete the call and release, after the DK relay operates.

These time intervals are considerably greater than the marker requires to perform its functions, if no trouble is encountered.

When the circuit times out in any one of the three stages, the trouble indicator circuit is called in, if available, to take a record of the call. The marker and associated circuits are then released. If the trouble indicator is found busy and the TRL lead is grounded, the RL1 relay operates immediately disconnecting the marker and associated equipment without recording the trouble.

Should some trouble prevent the trouble indicator from being called in, the marker continues to count time for a fourth stage of an additional 4.240 seconds, if the marker trouble occurred during the first stage or 1.060 seconds for the second and third stages, after which a trouble release signal is given to the sender and the marker is restored to normal.

On overlapped calls, the TM lead, which is the control lead for the short time-out circuit, may be continuously grounded for several calls. That is before the marker stage of one call is completed another call may start decoding, which is the first stage. During the busy hour it is quite likely to be continuously grounded for periods longer than the maximum short time-out period. The short time-out circuit is consequently arranged to recycle itself on the completion of each call so that it will not time-out, even though the TM lead is continuously grounded, provided that each call progresses through the marker in a normal time.

SHORT TIME-OUT - FIRST STAGE - OS 341

MIN. .535 SEC. TO MAX. 1.595 SEC.

When the marker connector circuit operates its multicontact relays ground is connected to the TM lead to the marker causing the time measure start relay TMS1 to operate, this causes ground to be connected to the TM interrupter. The open and closing of the back contact of the TM interrupter causes the TMW and TMZ relays to function and controlling the TM1 relay.

> The B contact of the TM interrupter closes for .525 second and is open for .535 second.

If, due to a trouble, the CK1 or CK3 relay is operated or the CK4 relay is normal the DL relay and the TR relays operate.

> If the TR relay operates, it calls in the trouble indicator circuit, if available, to take a record of the call and release the circuit

If the trouble indicator is busy, the TIB relay is operated from the busy trouble indicator. With the TIB relay operated when the TR relay operates, the RL1 relay operates and the TRL lead is grounded. The RL1 relay operates the RL relay to release the associated circuits.

SHORT TIME-OUT - SECOND STAGE - OS 341

MIN. 3.715 SEC. TO MAX. 4.775 SEC.

If registration has been properly completed and the DL relay has not operated the circuit continues to count time for the second stage. The action of the TM interrupter causes the TMW and TMZ relay to function which in turn controls the operation of the TM4, TM5 and TM6 relays.

If the DK relay has not operated by the time the TM6 relay operates the TR relay will operate.

> If the TR relay operates, it calls in the trouble indicator circuit, if available, to take a record of the call and release the circuits.
>
> If the TR relay operates and the trouble indicator is busy, a trouble release signal is sent to the sender and the marker restores to normal.
>
> If the DK relay operates within the allowed time and the circuit consequently does not time out, operation of the DK relay releases the TMS1 relay at an earlier point. The TMS1 relay released releases the TM1 relay which releases any other TM relays that may be operated, cancelling any remaining time for the second stage.

SHORT TIME-OUT - THIRD STAGE - OS 341

MIN. 1.595 SEC. TO MAX. 2.655 SEC.

If the DK relay has operated within the allowed time then the third stage of timing starts. The TMS and the TMS2 relays operate and lock.

> The operating path of the TMS2 is under control of the normal contacts of the time measure relays to insure that these relays are not left operated from the second stage when the third stage is started. When the AK relay and the CK relay operate, each closes a locking path for the TMS relay, so that the time measure will continue after the DK relay releases.

Ground is connected to the TM interrupter and its action causes the TMW and TMZ relays to function, which in turn controls the operation of the TM5 and TM6 relays.

If the marker has not restored to normal when the TM6 relay operates, the DL relay will operate followed by the operation of the TR relay.

> If the TR relay operates, it functions as before to call in the trouble indicator circuit, if available. If the trouble indicator circuit is busy, a trouble release signal is sent to the sender and the marker restores to normal.
>
> If the circuit completes the call and restores to normal within the time allowed after operation of the DK relay and consequently does not time out, the TMS2 relay releases when the ST1 relay releases. Release of the TMS2 relay releases any other TM relays that may be operated.
>
> If the TM lead is kept grounded due to overlapped calls, the TMS1 relay reoperates when the TMS2 relay releases, in order to start the first stage of the time measure for the next call. The operating path for the

TMS1 relay is under control of the make contacts of the connector DMA relay or ST1 relay and the normal contacts of the DK, TMS2, TM1, TM5, TMZ and TMW relays to insure that the timing relays release before another cycle of timing is started.

ADDITIONAL RELEASE TIMING - OS 341

4.24 SEC. OR 1.06 SEC.

If at any time the DL relay operates and the trouble indicator circuit cannot be called in due to some condition other than a normal busy, the timing circuit continues to time. This timing continues after the DL relay operates, with the TM1 or TM6 relay operated.

With a first stage failure recorded and the TM1 relay operated, the timing circuit must operate for 3.18 seconds to operate the TM6 relay and then an additional 1.06 seconds to operate the TM7 making a total of 4.24 seconds elapsed time. If a second or third stage failure had been recorded by operation of the TM6 relay then only 1.06 seconds of additional timing will cause the TM7 relay to operate.

In any case when the TM6 relay is operated, the timing circuit continues to time under control of the TM interrupter and the TMW and TMZ relays causing the operation of the TM7, RL1 and TM10 relays.

The DK lead is opened and battery is removed from the ST lead to the office link and connector frames causing them to release and in turn releasing the district link frame.

Ground is connected to the TAP and MB lead to the trouble indicator frame and to the TA lead to the miscellaneous circuit for the marker frame. These leads are grounded to actuate alarms.

Ground is connected to the TRL lead to the marker connector and to the TRL lead to the district link and connector circuit.

The trouble release signal is sent through the connector circuit if it has not already been released. The sender then releases the connector and makes another trial, except for third trial calls.

If the marker connector has already been released the trouble release signal is sent by way of the district junctor and sender link. However, since the TM7 relay opens the ST lead to the office link and connector circuit, causing the office and district frames to release, the trouble release ground connected by the TM10 relay may not be connected long enough to register in the sender before the TRL lead is opened by the release of the district link and connector circuit. If this should happen the sender would be stuck and would time out. It is thought better to do this, however, than to risk the possibility of not releasing the district and office in case some abnormal condition should prevent the operation of the TM6 relay from causing the marker to restore to normal.

Marker circuit RL and MRL relays operate.

> The MRL relay operated causes the marker to restore. When ground is removed from the TM lead by the marker connector circuit and with the ST1, XRL, XX1 and XX2 relays in the marker normal, the TM2 and TM7 relays release. Release of the TM2 relay causes the TM4, TM5 and TM6 relays to release. The TM7 relay released removes ground from the TRL lead.
>
> The TM10 relay locks under control of the AR key on the marker frame and the marker is held out of service until the key is depressed. The TM10 relay lights the MB and DT lamps on the trouble indicator frame and the TA lamp on the marker frame.
>
> Since the DK relay releases when the ST5 operates it is necessary to lock the TMS relay to the CK which usually remains operated until the end of the call. However, when it is necessary to release one trunk because no channels are available to it and then select a trunk on the mate frame, the CK relay will be released momentarily in this progress. To prevent release of the TMS relay, a locking circuit is provided to a contact of the AK1 relay.

LONG TIME-OUT - OS 341

MIN. 12.0 SEC. TO MAX. 19.0 SEC.

The DB interrupter and the TM8, TM8B, TM8C, TM9 and TMS relays are provided for sounding an alarm and releasing the associated circuits if some trouble should occur that would prevent the short time-out relays from functioning, or if the DB lead should become permanently grounded and thus keep the marker out of service. The time-out period in this case is from 12 to 19 seconds, depending upon the position of the interrupter at the time that ground is connected to the DB lead.

With the DB lead grounded the action of the DB interrupter causes the operation of the TM8, TM8B, TM8C, TM9 and TM10 relays to operate and lock.

> Ground is connected to the TAP and MB leads to the trouble indicator frame and the TA lead to the miscellaneous circuit for the marker frame. These leads are grounded to actuate alarms.
>
> Ground is connected to the TRL lead to the marker connector and to the TRL lead of the district link and connector circuit.

Marker circuit MRL relay operates and locks.

> These operations assume, of course, that the DB lead was continuously grounded and that the TMS relay was not operated from the DK relay or after this that the TMS relay did not release either due to setting up the connection and releasing the district link or because the short time out failed to cause the frame to be released.

When the DK relay operates from the district link being selected for the call, the TMS relay operates. This opens the DB lead and connects direct ground to the DB interrupter. The TM8, TM8B and TM8C relay if operated will be released. With the TMS relay operated and the TM8 and TM8B relays released, when the B contact of the DB interrupter closes the TM8A relay operates and locks. This arrangement recycles the long time-out for 12 to 19 seconds when the call has advanced to the marker stage.

The reason for opening the DB lead and connecting ground to the DB interrupter is to continue the long time-out circuit even though there is not another call waiting to be served by a marker and therefore the DB lead might not be grounded after the marker connector lead released. Without this arrangement and should the short time-out circuit fail the marker could not time-out.

The TM9 relay may operate then with either the TM8 or TM8A relay operated. If when the TM9 relay operates should the office and district link frames be connected the office start lead is opened, releasing both these frames. The locking circuit for the ST5 relay is also opened, releasing this relay if operated.

The TRL lead is grounded through the marker connector and through the district link when the TM10 relay operates. This may give two senders a trouble release, if there is a call in the decoding stage and another in the marker stage.

When the call has been set up and the CK relay has released the TMS relay is released and the TM8A relay if operated also releases and then if the DB lead is still grounded the timing starts again for operating the TM8 relay.

CONDENSER TIMED TIME-OUT - OS 341

Should a marker block after seizing the office link or the district link, any other marker which is waiting for that frame will block, and both markers will start timing. If the waiting marker should time out first, it would seize the trouble indicator and make it busy before the marker which is in trouble can record its trouble.

In order to avoid this condition and to save marker holding time when such trouble occurs, also to insure that the marker in trouble will quickly disconnect from the link frames, the condenser timed TM relay is provided. This relay operates in about 0.4 second, allowing this length of time for certain functions and timing the marker out if the functions are not completed within this interval.

When the marker is normal a short-circuit is maintained across the TM condenser by a break contact of the OCB relay. This insures that this condenser has little or no charge when the marker starts a call.

When the ST2 relay operates, the primary and secondary windings of the TM relay are both energized. The secondary winding being the stronger of the two and being energized in the released direction causes the relay to be driven to its back contact.

As soon as the marker seizes the office link frame, the OCB relay operates, removing the short-circuit from the TM condenser and opens, the energizing circuit for the secondary winding of the TM relay. However, the TM relay does not operate immediately because current continues to flow through the secondary windings until the large TM condenser becomes charged. In the meantime, the marker should pick a trunk and select the district link, causing the CK and BK relays to operate. Prior to the selection of the office link the marker is not affecting other markers and therefore the condenser timed time-out is not required.

In case the marker finds all trunks busy on the office link frames, it releases these frames dropping relay OCB which discharges the TM condenser. Then if another pair of office frames are seized, the OCB relay reoperates and starts the TM relay timing anew.

When the district link is selected, the BK relay operates and closes ground through a front contact of the SPT relay to re-energize the secondary winding of the TM relay and discharge the TM condenser. The operation of the BK relay also releases the SPT relay, but this release is delayed slightly by a shunt on the winding of the SPT relay by the TM6 and TM7 resistances, in order to allow sufficient time to discharge the TM condenser.

The SPT relay is releasing for the purpose of recycling the TM relay and TM condenser after the BK relay operates, to again time, but for release of the marker.

In case the district link frame has not been seized by the time relay CK operates, then the BK relay will not operate immediately to recycle the TM relay timing. However, with relay CK up, the TM condenser is connected through a back contact of relay TMS and a front contact of the IF- relay to the CB lead to the district link frame wanted. If the district link frame is busy with any marker, the CB lead is grounded, discharging the TM condenser. Then, as soon as this marker seizes the district link frame, the TMS relay operates, removing ground from the TM condenser to start timing for the BK relay to operate.

When the BK relay operates, the marker then proceeds to test for a channel, set up the connection and release, which should occur before the TM relay operates. Upon completion of the marker operation the MRL relay operates and discharges the TM condenser, preventing any further operation of the TM relay or should there be an overlap call the condenser timing is prepared.

In case all channels of the first choice test busy, the marker will test other choices, in which case the BK relay is released each time the district link JC- relay releases. The release of the BK relay operates the SPT relay and then when the BK reoperates, ground is connected to the TM condenser during the release time of SPT, recycling the TM relay timing.

If a permanent signal occurs on a line whose M lead is open to deny originating service, the marker function requiring a timing longer than the condenser timed time-out. There, this time-out is cancelled by a path through the MR1 and PS1 relays operated.

On a second trial when only one office link frame is connected, the BF relay in conjunction with the XBE or XBO relay recycles the timing. On marker test calls relay CIF-1 relay cancels the timing.

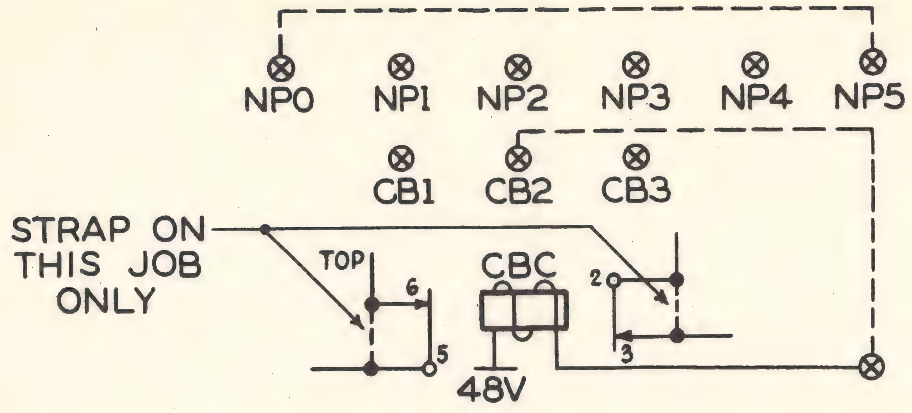
On zone charge calls, after the BK relay has operated, this timing is cancelled until either the ZL or ZO relay has operated. This prevents false time-out while waiting for the zone charge circuit.

Should the marker block because of trouble at a time when none of the condenser discharge paths are effective, condenser TM charges until the current in the secondary winding of the TM relay is reduced to a point where the primary winding takes control and operates TM. This in turn operates the DL relay which causes the seizure of the trouble indicate, followed by a trouble release.

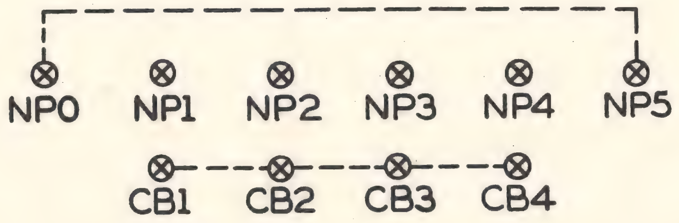
MARKER MAKE BUSY

A marker circuit may be made busy manually by inserting a make-busy plug in a make-busy jack at the trouble indicator frame. This causes ground to be connected to the DJ lead to the marker circuit, operating the DB relay to battery on the B lead. The DB relay operated operates the CBR, CBS and CBT relays, which connect ground to the CB leads to the connector circuits.

TWO-TWO JOB: *

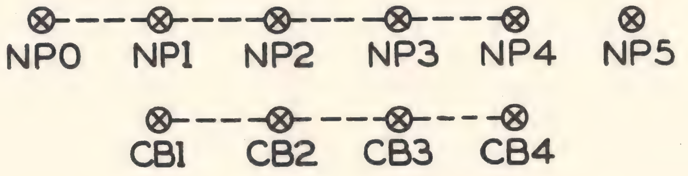


FOUR-FOUR JOB AFTER AN ADDITION: *

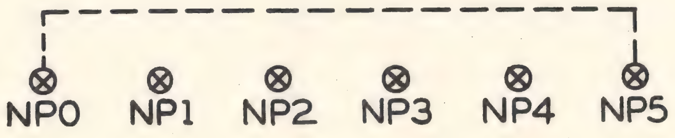


SIX-SIX JOB AFTER AN ADDITION OR FOUR-FOUR NEW JOB. *

EIGHT-EIGHT JOB AFTER AN ADDITION OR SIX-SIX NEW JOB. *



TEN-TEN JOB AFTER AN ADDITION OR EIGHT-EIGHT NEW JOB



* USE Z WIRING AND FIG. 38.

USE W WIRING.

ORIGINATING MARKER
STRAPPING FOR FIG. 17
SD-25016-01

CHAPTER 5

SECTION 6

ZONE REGISTRATION CALL FOR NONCOIN DISTRICT JUNCTORS

Originating Marker Circuit	SD-25016-01
District Junctor Circuit	SD-25020-01
District Link and Connector Circuit	SD-25031-01
Zone Registration and Control Circuit	SD-25320-01

MARCH 1954

GENERAL

This section covers a description of the zone registration equipment, its purpose and functions, followed by a description of its method of operation.

PURPOSE OF CIRCUIT - RM 322, 323, 324, 325, 5-9, 5-10

The zone registration control equipment is designed to automatically select a zone registration circuit and connect it to the district junctor requiring its services on any one of five different zones, which would otherwise require the assistance of an operator. The zone registration circuit is arranged to operate the message register of the calling subscriber 1 to 5 times for an initial period of 3 or 5 minutes, after the called subscriber answers and reoperates it once or twice for each overtime period of 1, 2, 3 or 5 minutes according to the zone called.

DESCRIPTION OF EQUIPMENT

ZONE REGISTRATION DISTRICT CONNECTOR FRAME - RM 323, 324

The zone registration district connector frame consists essentially of 12 conventional 200 point 4-wire crossbar switches mounted in a single bay. Each switch is referred to as a district connecting switch. The 20 verticals of each switch are cabled to a group of twenty district junctors associated with two primary switches on a district link frame, requiring the use of zone equipment. The horizontals of these switches are connected to the zone registration circuits and are strapped through 10 or 20 verticals, depending upon the number of zone registration circuits required. Between switch No. 4 and No. 5 is mounted the miscellaneous jacks and lamp equipment.

Each zone connector frame is capable of serving a total of 240 district junctors. The district junctors associated with one district link frame are wired in most cases to district connecting switches adjacent to each other on one connector frame. This is for the purpose of grading. Since there are a maximum of 100 district junctors on one district link frame, five district connecting switches are required to accommodate them at the zone connector frame. On most of the jobs where coin district junctors are equipped, only 20 appear on one district link frame. This reduces the number of district junctors to 80 that would be wired to the zone connector frame, if required. Under this condition, four district connecting switches are used for one district link frame. In most cases, one zone connector frame will be accommodating three district link frames with its 12 connecting switches.

Each district junctor can have access to 10 zone registration circuits as required. In order to reduce the number of zone registration circuits to a minimum economically, provision is made for two kinds of graded multiple; namely, intra-frame grading and inter-frame grading.

Intra-frame grading consists of arranging the zone registration circuits on the horizontal multiple of the district connecting switches in individual and common groups made accessible only to those district junctors associated with a particular district link frame. In this case the individuals would be connected to one switch only, while the commons would be multipled to all switches for the one district link frame.

Inter-frame grading consists of arranging the zone registration circuits so that an individual group is common to all connecting switches associated with one district link frame, while the common group is multipled to the connecting switches of more than one district link frame.

By an "individual" group of zone registration circuits is meant a group of circuits that are accessible to a relatively small number of district junctors, while a "common" group is a group that is made available to a relatively large number of district junctors. In other words, a larger number of district junctors have access to a common group than to an individual group.

The individual groups appear in the lower levels of the district connecting switches, while the common groups appear in the upper levels. The circuit uses these groups in a definite order; thus, when a zone registration circuit is to be selected the circuit will prefer an available one of the individual group before it will select one of the common group. Hence, the common group represents a group that will accommodate the "overflow" calls.

On jobs where neither the intra or inter-frame grading is used, the zone registration circuits are wired on a nongraded basis. That is, they are common to all district junctors on the zone connector frame.

ZONE REGISTRATION TIMING INTERRUPTER FRAME - RM 323, 324

The zone registration timing interrupter frame is used for mounting the timing interrupter circuits and the 206-type rotary selectors of the zone registration circuits. The frame accommodates fourteen units within one framework. A timing interrupter frame may serve seventy or less zone registration circuits, each of which is associated with one 206-type rotary selector.

Each unit consists of one timing device, three relays and five 206-type rotary selectors, together with contact protection equipment.

This timing device is known as a No. 2A timer and consists of a telechron motor whose shaft is geared to an eccentric disc which has a high spot for actuating a set of contacts. It takes 15 seconds to complete one cycle of the eccentric disc. This eccentric disc in rotating causes its high spot to close the set of contacts for 1.5 seconds during each 15 second cycle.

The 206-type rotary selector has six brushes, two bridging and four nonbridging. Brush 1, 3 and 5 of the rotary unit are diametrically opposite to brushes 2, 4 and 6. This arrangement of the brushes gives a selection of 44 terminals and requires one complete revolution of the rotary unit to pass over all terminals.

ZONE REGISTRATION CONTROL FRAME - RM 323, 324

The zone registration control frame is used to mount the relay equipment for the zone registration circuits, connector circuits, control circuits and the group busy circuits. Each frame has a capacity of sixty mounting plates.

INTERRUPTER FRAME - RM 323

Each timing interrupter circuit mounted on the zone registration timing interrupter frame has a ZR interrupter which is associated with the regular crossbar interrupter frames. The ZR interrupter closes for .295 second, every .5 second cycle.

SUMMARY OF OPERATION

When a call has progressed to the point where the marker operates the route relay for a zone call, the marker connects itself to the district link frame and then proceeds to select the district junctor attached to the call. With the district link frame attached and the marker set for a zone call, a zone start signal is sent to the zone registration and control circuit.

The zone control circuit immediately proceeds to select an idle individual zone registration circuit, or if these are busy, it selects a common zone registration circuit, either of which are connected to the district junctor involved in the call.

The zone registration circuits appear on the horizontals of a zone district connecting crossbar switch and attached to the verticals are the district junctors requiring zone timing. Upon the selection of the idle zone registration circuit, the zone control circuit operates its associated select magnet on the connecting switch and then operates the hold magnet of the vertical associated with the district junctor which requires its services.

With the zone registration circuit attached to the call, it proceeds to prepare for the registration and timing of the call by connecting AC current to a telechron motor of a timing device which starts to rotate but does not start timing until the called line answers.

After the marker has selected and closed the channel, the release of the district link frame causes the release of the zone control circuit.

When the called subscriber answers and the district junctor is set for charging the call, a start signal is sent to the zone registration circuit, which proceeds to operate the message register of the calling line 1 to 5 times depending upon the zone called and immediately starts counting time for the initial period of 3 or 5 minutes.

The registration and timing is controlled by the advancement of a rotary selector of the 206-type, which is operated by the synchronizing of an interrupter and the 2A timing device.

After the initial period of time is counted which is one cycle of a 206-type selector, the selector continues to cycle, once for each overtime period required. At the start of each overtime period, the message register is operated once or twice and timed for a 1, 2, 3, or 5 minute period, depending upon the zone called.

When either the calling or called party disconnects, the start signal to the zone registration circuit for timing is removed, thereby stopping the timing circuit. The release of the zone registration circuit depends only upon the disconnection of the calling party.

Should all zone registration circuits be busy when a district junctor calls for one, the marker is informed by the busy condition which will then set the district junctor for a talking charge, in which case the message register will be operated only once and no count will be made of the time that the connection is held.

METHOD OF OPERATION

ZONE REGISTRATION CALL - OS 343

For those routes that require zone charge, the marker is provided with ten zone conditions. These ten zone conditions are controlled by the marker ZA to ZJ relays. The code points of those routes requiring a particular zone are wired to the RC punchings of the route relays and the R punchings of these route relays are cross-connected to an SC punching of the class of service relays. The corresponding S punching of the class of service relay requiring the zone registration for these routes is cross-connected to one of the ZA to ZJ relays.

When a call requiring zone registration selects the marker, the marker proceeds to decode the information received causing the operation of the R and ZA relays in series.

> Since there a possible ten zone conditions (ZA to ZJ relays) furnished in the marker for the purpose of the information that follows it, will be assumed that the first zone (ZA) is required for the call. Any one of the ZB to ZJ relays when operated perform the same type of functions as the operation of the ZA relay.

Marker circuit ZA1 relay operates and locks.

> This path includes the winding of the marginal XC relay, provided to detect false grounds and crosses on the charge relays. It does not operate unless two or more windings of charge relays are grounded. If it operate during a call due to a trouble, it causes the circuit to stick and call in the trouble indicator, or should a trouble develop during the time that a marker is normal, it will also call in the trouble indicator.

Ground is connected to the ZA lead to the zone registration and control circuit.

> This ground is connected for operating a relay in the zone registration circuit later on in the call.

SELECTION OF ZONE REGISTRATION EQUIPMENT

HAVING INDIVIDUAL GROUP CONNECTORS - OS 343

For the purpose of this description it is assumed that Figs. 1, 2, 3, 4, 5, 6 and 8 are used with G and E wiring.

The marker after operating its route relay selects the office link frame, which in turn causes the district link frame to be selected. The district link frame MCA and MCB relays in operating connect ground to the ZK lead as an additional locking circuit for the marker ZA1 relay. The district link frame connected to the marker causes the subscriber's sender DC relay and the F relay of the district junctor originating the call to operate. The F relay in operating extends its operating ground to operate the district link frame LC relay associated with the primary switch having the district junctor. When the LC relay operates, the zone registration and control circuit is called in.

District connecting switch SM relay and the zone control circuit SB relay operate in series.

> The ground for operating the SM and SB relays is furnished at the operated contacts of the marker ZA1 relay over the ZS lead through the district link frame MCA and LC relays operated.
>
> There is one Fig. 2 for each district connecting switch which represents a group of 20 district junctors. Therefore, the vertical element in Fig. 2 represents 20 verticals of one 200 point switch.
>
> The armatures of the SM relays and the contacts of the select magnets of all Figs. 2 associated with district junctors of the same district link frame are multipled together and connect to one Fig. 4.
>
> There is one Fig. 4 for each group of 100 or less district junctors which are mounted on the same district link frame.

Zone control circuit ZB relay and zone connector circuit Z relay operate.

> There is one Fig. 5 furnished per marker for each Fig. 4. The armatures connected to the ZA to ZE, ZL and ZR leads of one marker are multipled to all associated Z relays of other Fig. 4. The A and B leads of Fig. 5 are individual to the Fig. 4 and connect to the ZB relay. The ZB relay is arranged to accommodate eight Figs. 5, which is the maximum markers per office.

Individual group connector circuit BT relay operates.

The ground for operating the BT relay is furnished at the operated contacts of the marker ZA1 relay over the ZS lead through the district link frame MCA and LC relays operated to the ZS1 lead.

There is one Fig. 3 for each group of 10 or more district junctors having access to the same Fig. 1. For example: if a district link frame had 80 district junctors connected to a zone registration district connector frame and assuming that three Figs. 1 were to be common to these 80 district junctors, they would then in this case be multipled to just the four switches on the zone connector frame associated with these district junctors. Fig. 3 then is for the purpose of closing through just those individual Figs. 1, associated with the district junctors of one district link frame to the associated Fig. 4.

Individual group connector CT relay and zone control circuit S relays, corresponding to idle zone registration circuits, operate.

There are 10 S relays designated S0 to S9 in each Fig. 4 and are used to test for idle zone registration circuits. When the BT relay operates the BT0 to BT9 leads are closed, connecting the BT leads of the zone registration circuits to the primary windings of the S relays. The number of S relays to be involved in the test at the time that the BT relay operates depends upon the number of individual zone registration circuits being used. This may be any number from a minimum of one to a maximum of ten.

The use of intra or inter-frame grading is desirable to reduce the required number of zone registration circuits. This makes it necessary to assign the zone registration circuits of the individual group to the lower horizontal levels and those of the common group to the upper levels.

Of the working BT leads, those that are busy on other calls will have a solid ground on the BT lead from the bottom No. 8 contact of the HD relay. This ground shunts the primary winding of the associated S relay. It is used as a precaution to prevent multiple seizure of a zone registration circuit due to trouble "crosses."

Zone control circuit SE, R and SE1 relays operate and the lowest numbered operated S relay locks. All operated S relays, numbered higher than the one locked, release.

OPERATION OF SELECT AND HOLD MAGNETS - OS 343

District connecting switch select magnet operates.

The select magnet to operate is controlled by the S relay that is locked in for the call and will be associated with the horizontal having the selected zone registration circuit.

Zone control circuit HM relay and district connecting switch H hold magnet operate.

The circuit for operating the H hold magnet is traced from battery on the hold magnet, DH lead to district junctor, operated contacts of F relay to HM lead to the zone control circuit HM relay operated to ground. The HM relay in operating connected ground to the ten groups of district junctors served by the associated district link frame. Since only one call can be served by the associated district link frame, only one F relay will be operated in one particular group and therefore only one HM lead ground will find its way back to one hold magnet.

The hold magnet in operating closes the contacts of the crosspoints at the level of the operated select magnet.

District connecting switch H hold magnet locks.

The marker after selecting the idle trunk for this call operates the DRL relay in the subscriber's sender for disconnecting the marker connector. When the DRL relay operates it connects ground to the LR lead to the district junctor. This LR lead ground locks the H hold magnet on a zone call.

On a nonzone call the TC relay is operated in the district junctor by the marker and this same LR lead ground is used in this case to lock in the TC relay and at the same time send back a check signal to the marker. On the nonzone call the LR lead ground goes through the normal contacts of the district connecting switch hold magnet, via the BC and HD leads.

The BC and HD leads also serve another purpose in case the subscriber's sender receives a premature disconnect before the hold magnet is operated on a zone call. Should this occur, the sender connects battery to the LR lead for operating the district junctor I relay.

ZONE REGISTRATION CIRCUIT CONNECTED TO CALL

With the district connecting switch hold magnet operated and the crosspoints closed, the zone registration circuit TC relay operates and the 300 ohm B resistance and battery is short-circuited.

The TC relay is slow operate to insure that the DC and ST crosspoints of the district connecting switch involved in the connection have had sufficient time to close.

The number of Figs. 1 are provided in accordance with the calling rate and holding time of zone registration calls. Each district junctor can have access to a maximum of 10 zone registration circuits. These may be individual or common groups or a combination of both. The zone equipment uses these groups in a definite order when both are provided; thus, when a zone registration circuit is required, the circuit will prefer an available circuit of the individual group to which the calling district junctor has access before it will attempt to select a circuit of the accessible common group.

For this call it is assumed that there is a combination of both and the one selected is an individual. The individual group appears on the lower levels of the district connecting switch.

Zone registration circuit ZA relay operates.

When the TC relay operates the ZA to ZE leads from the marker, one of which has been grounded by the marker, are closed through the ZA to ZE relays operating the relay associated with the grounded lead. While there are a total of ten zone leads ZA to ZJ in the marker, only five are connected to the zone registration equipment.

Zone registration circuit HD relay operates.

Battery is disconnected from the BT lead, ground is connected to the BT and N leads of the zone registration timing test circuit and to the primary winding of the associated zone control circuit S relay.

Group busy circuit GB relay releases.

If zone registration circuit selected is the last circuit idle in the individual group.

There is one Fig. 8 for each group of individual zone registration circuits provided in an office.

The group busy circuit GB relay may or may not release when the HD relay operates, this depending upon whether it is the last circuit idle in the group. The GB relay is connected to all GB leads of the individual zone registration circuits in one group, or those circuits that are individual to the district junctors associated with one district link frame.

Marker circuit ZL and ZCK relays operate.

The operation of the ZCK relay is an indication that the zone registration circuit ZA to ZE relays, whichever one has been operated, is locked in for the call. When the marker ZL relay operates it removes the operating ground from the zone registration circuit ZA relay and connects the ZCK relay to the winding of the ZA relay to receive its locking ground. The operation of the ZCK relay closes through the SL lead which will be connected to the sleeve of the primary crosspoint of the district link frame for checking the channel.

Should the ZCK relay fail to operate indicating that the zone charge has not been properly registered in the zone registration circuit, the call would be blocked, due to the failure of the SL relay to operate on channel check. The trouble indicator is called in after which the subscriber's sender is given a trouble release. The sender would in this case make a second trial.

At the time the zone registration circuit ZA relay operates, in addition to operating the HD relay, the following takes place:

Timing interrupter circuit ST relay operates.

There is one Fig. 6 provided for each group of five zone registration circuits. Therefore the TS leads for the five circuits are common to the TS lead of the Fig. 6, while the A, B, C and D leads for each of the five circuits are connected to individual groups of leads at the Fig. 6.

The 22-volt, 60-cycle AC current is connected to the telechron motor of the 2A timer, which starts rotating. The M relay of the timing interrupter circuit is connected to the ZR interrupter and ground is connected to the T interrupter of the 2A timer. When the B contact of the ZR interrupter closes it causes the operation of the timing interrupter M relay.

The M relay operates every .5 second cycle for a period of .295 second, during the time that the ST relay is operated. It closes through the C and D lead for the five associated zone registration circuits.

When the T contacts of the 2A timer closes it causes the operation of the timing interrupter circuit T relay and ground is connected to the T lead to the zone registration and timing test circuit.

The T relay operates every 15 seconds cycle for a period of 1.5 seconds, during the time that the ST relay is operated. It closes through the A and B leads for the five associated zone registration circuits.

DOUBLE CONNECTION TEST AND TEST FOR GROUNDED "ST" LEAD - OS 343

At the time that the TC relay operates, a double connection test is made to determine whether or not the crosspoints have been closed to an established connection at any of the other switches of the zone connector frame. It also checks to see that no ground is crossed with the ST lead coming from the district junctor or that the district junctor has not connected ground prematurely to the ST lead.

When the TC relay operates the DC and ST leads from the crosspoints are connected between the 500 ohm battery and the winding of the HD relay. Should there be any ground on either of these leads, the HD relay is prevented from operating due to its operating battery being shunted. This prevents the ZL and ZCK relays from operating in the marker. The ZCK relay in not operating holds open the SL lead from the district link primary crosspoints preventing the check of the channel from being completed, thereby blocking the call.

DISCONNECTION OF MARKER AND ZONE CONTROL - OS 343

When the marker has completed its check of the selected channel, the district link frame LC relay releases causing the zone control to release.

Zone control circuit SB, ZB, HM, S, SE1, SE and R relays release.

Individual group connector BT and CT relays release.

District connecting switch SM relay and select magnet release.

Zone registration circuit TC relay and zone connector circuit Z relay release.

Marker circuit ZL and ZCK relays release.

> When the district link frame MCA and MCB relays release, the marker ZA1 relay releases.
>
> The release of the R relay makes this zone control circuit available for another call, should the same district link frame originate another zone call.

REGISTRATION - INITIAL PERIOD

When the called subscriber answers on a zone registration call and assuming that there were idle zone registration circuits, the district junctor circuit CS relay is operated from reverse battery in the incoming trunk. The district junctor has its usual delay before operating the I and CH relays. With both the I and CH relays operated, ground is connected to the ST lead to the zone registration circuit attached to the call.

When the timing interrupter circuit M relay operates and releases it causes the zone registration circuit rotary switch to advance its brush assembly to terminal 2.

> The M relay operates and releases under control of the ZR interrupter each .5 second during the time that the ST relay is operated. At the time that ground is connected to the ST lead at the district junctor, the ZR interrupter may be closed and the relay operated. In this case the rotary switch STEP magnet is energized immediately.

Short circuit is removed from the zone registration circuit MR relay which operates and also from the calling subscriber's message register.

When a call is originated and the line link frame crosspoints are closed to the district junctor, the subscriber's message register is guarded against false operations by being short-circuited. Its first short-circuit is received from the normal contacts of the district junctor CH relay. After the F relay operates, the ground is removed to allow the marker to check the MR lead.

When the F relay releases it is transferred back to the CH relay. After the called subscriber answers and the I and CH relays are operated it is transferred to the normal contacts of the zone registration circuit MR relay.

Calling subscriber's message register operates.

The subscriber's message register is always operated for the first time from terminal 2 of the rotary switch on every call for the initial period. It will also be operated each time the rotary switch passes terminal 2 during the timing of the overtime period.

Zone registration circuit rotary switch advances to terminal 3 under control of the timing interrupter circuit M relay. The zone registration circuit MR relay and the calling subscriber's message register release.

Short circuit is connected to the calling subscriber's message register.

The rotary switch continues to advance from terminal 3 to terminal 11 under control of brush 5 and the M relay.

As brush 1 of the rotary switch passes over terminals 4, 6, 8 and 10, the zone registration circuit MR relay may or may not operate for the initial period, depending upon the manner in which leads 4, 5 and 6 of the operated ZA relay are cross-connected to leads N and IC associated with the OT relay. This is governed by the requirements of the zone involved on the call. For each position of the aforementioned terminals when it is desired to operate the subscriber's message register, the corresponding lead of the groups 4, 5 and 6 of the ZA relay is connected to the IC lead of the OT relay. Those positions in which it is not desired to have the message register operated, the corresponding lead is connected to the N ground. The N ground serves to short-circuit the MR relay. As brush 1 passes over terminals 3, 5, 7 and 9, and later over terminals 11 to 22, the MR relay is short-circuited.

The time required to pass from terminal 1 through terminal 10 is 5 seconds.

When the rotary switch reaches terminal 11, both the M and T relays of the timing interrupter circuit must be operated at the same time to advance the rotary switch to terminal 12. This depends upon the

ZR interrupter and the T contacts of the 2A timer being closed at the same time. The 2A timer closes its contacts for 1.5 seconds during every 15 second interval. The ZR interrupter will close its contacts and open them at least once during the 1.5 second closure of the 2A timer contacts.

Since this is the first time that the 15 second pulse is used, it is possible that when the rotary switch reaches terminal 11, the T relay will be operated when the next .5 second pulse is closed to operate the M relay. It is also possible that the 1.5 second pulse may just open when the rotary switch reaches terminal 11 and would have to wait a full 13.5 seconds before the next closure. Therefore, the time interval to advance from terminal 11 to 12 may vary from .5 to 14 seconds. This time, due to the above possibility is not counted into the total time for the initial period.

With the rotary switch on terminal 11 and the M and T relays operated.

Zone registration circuit rotary switch advances its brush assembly to terminal 12.

From terminal 12 through terminal 22 the rotary switch is advanced under control of arc 5 and the M relay, stopping on terminal 23.

TIMING FOR INITIAL PERIOD - OS 343

When the rotary switch reaches terminal 23, it must wait for the 15 second interrupter to close and operate the T relay before the STEP magnet can be energized through arc 6 for advancing the switch to terminal 24. Since the rotary switch required both the M and T relays operated to advance from terminal 11 and the time varied from .5 second to 15 seconds, it can be stated definitely that the first full 15 second interval can be counted after the switch leaves terminal 11 and before it will leave terminal 23.

With the switch on terminal 24, it again awaits for the 15 second interrupter before advancing to terminal 25. Up to this point 35 seconds have been counted against the call.

It can be seen from the circuit arrangement of arc 6 that the rotary switch will continue to advance from terminal 25 through 43 under control of the 15 second interrupter, unless other circuit arrangements can be made to use the .5 second interrupter. Arc 4 of the rotary switch is used to vary the effects of arc 6, this depending upon the initial time period assigned to the zone.

As the switch passes by terminals 25 to 28 which are strapped, the brush of arc 4 is connected to lead 1 on the operated contacts of the ZA relay. It also is connected to lead 2 as it passes by terminals 29 to 32 and to lead 3 as it passes by terminals 34 to 41. If the initial period is to be five minutes, the 1, 2 and 3 leads at the ZA relay are connected to the T lead at the OT relay and none of the 15 second intervals are cancelled for advancing the switch from terminals 25 through 41. The purpose of connecting the 1, 2 and 3 leads to the T lead is to guard against time being cancelled should these leads become falsely grounded. Should this occur, the false ground holds the STEP magnet operated, preventing any further advancement of the switch.

If a three minute initial period is required, the 1 and 2 leads are connected to either the T or the IT lead, depending upon the time required for the overtime period. In either case the STEP magnet is connected for the safeguard during the initial period. The 3 lead is connected to the N ground which causes the brush of arc 4 to receive ground on each of terminals 34 through 41, operating the STEP magnet under control of the M relay for each .5 second interval. Therefore, from terminals 34 through 41 the 15 second intervals at arc 6 are cancelled for an equivalent of two minutes.

To pass from terminals 42 and 43 the .5 second interval is used under control of arc 4.

PREPARING FOR OVERTIME PERIOD - OS 343

As the rotary switch passes by terminal 43, the zone registration circuit is prepared for the overtime period.

Zone registration circuit OT relay operates, the safeguard is removed from leads 1, 2 or 3 and replaced with ground when the IT lead is used.

> The IT lead is only connected to the 1, 2 or 3 leads when it is required to cancel time in the overtime period but not to be cancelled in the initial period.

Battery is removed from leads 4, 5 or 6 and replaced with ground, when the IC lead is used.

> The IC lead is only connected to the 4, 5 or 6 leads when it is required to operate the MR relay in the initial period, but to be cancelled in the overtime period.

> With the rotary switch on terminal 44 and the OT relay operated, the 15 second interrupter is used to advance the switch to terminal 1.

> In reviewing the initial cycle of the rotary switch, the actual time to be counted against the call is summarized in the following table:

Time Counted Terminals	Initial Time Periods Five Minutes	 Three Minutes
1 through 10	5 Seconds	5 Seconds
23 and 24	30 "	30 "
25 through 28	60 "	60 "
29 through 32	60 "	60 "
33	15 "	15 "
34 through 41	120 "	Cancelled
44	15 "	15 Seconds
	305 Seconds	185 Seconds

305 Seconds 5 minutes, 5 seconds
185 Seconds 3 minutes, 5 seconds

REGISTRATION AND TIMING FOR OVERTIME PERIODS - OS 343

The registration and timing for any overtime period is with few exceptions the same as for the initial period.

The OT relay remains operated during all overtime periods. Its operation changes the condition of leads 1 to 6 of the associated zone relay.

Overtime registration can only be one or two operations of the message register, while the initial registration can be one to five operations. The 4, 5 and 6 leads are used for scoring the message register if the requirement calls for more than one scoring in either the initial or overtime period, or both. Terminal 2 of the switch will always score the message register once in each cycle of the switch and any additional scoring in either the initial or overtime periods depends upon the connection of the 4, 5 and 6 leads.

For example: Should it be required to score the message register five times in the initial period and once for the overtime period, the 4, 5 and 6 leads are connected to the IC lead. Under this condition with the OT relay normal, battery is connected to the 4, 6, 8 and 10 terminals for operating the MR relay in the initial period and upon the operation of the OT relay for the overtime period, the battery is removed from those terminals and replaced with ground. Should it be required to score the message register five times in the initial period and twice in the overtime period, then lead 4 is connected to the CH lead and leads 5 and 6 to the IC lead. Under this condition, battery is connected to terminals 4, 6, 8 and 10 with the OT relay normal and to terminal 4 only of this group when the OT relay is operated.

In summarizing the time for the overtime period, the 5 seconds required to advance from terminals 1 through 11 and which was counted in the initial period is increased to 15 seconds due to the 15 second interrupter being synchronized with the call when the overtime period starts. This 15 seconds is the interval of time for advancing off of terminal 11. The 15 seconds which was required to advance off of terminal 23 and which was counted into the initial period is cancelled in the overtime period, since the 15 seconds for terminal 11 replaces terminal 23. Terminal 23 is cancelled due to the OT relay being operated and connecting ground to terminal 23 of arc 4 making the .5 timing effective for this terminal.

Similarly, timing of 15 second intervals will be recorded in positions 24, 33, 44 and in positions 25 to 32 and 34 to 41 depending upon the zone overtime period requirements for the call being served.

DISCONNECTION BY CALLED OR CALLING PARTY - OS 343

When both the calling and called subscribers disconnect at the same time, the district junctor S, S1, T and CS relays release. The CS relay in releasing releases the I relay. When the T relay releases, it releases the CH relay and causes the zone equipment attached to the call to release.

Should the called subscriber disconnect without the calling subscriber disconnecting, the CS relay releases, releasing the I relay, which in turn disconnects the ground from the ST lead to the zone equipment attached. The zone equipment remains attached to the call, due to the T relay being operated. With ground disconnected from the ST lead, the zone registration circuit rotary switch, if in the initial cycle, will complete the revolution and stop any further timing. The same applies to any overtime cycle. Should the called subscriber after disconnecting remove the receiver from the switchhook before calling subscriber has disconnected and the district junctor has not timed out, ground is again connected to the ST lead causing the switch to again rotate.

Any time the district junctor T relay releases in the disconnection of a zone call the district connecting switch H hold magnet releases, the zone registration circuit HD and ZA relays release and the timing interrupter circuit ST, M and T relays release.

> If all other associated zone registration circuits have no ground connected to the TS lead the ST releases. The 22 volt AC current is disconnected from the telechron motor of the 2A timer.

The zone registration circuit rotary switch magnet is energized and de-energized for returning the switch to normal.

> In all positions, except position 1, 43 and 44, the rotary switch STEP magnet receives a circuit to return the switch to normal, whenever the HD relay releases.
>
> If on any terminals from 2 to 22 inclusive, the ground on arc 3 advances the switch to terminal 23. If on any terminal from 23 to 42 inclusive, the ground on arc 2 advances the switch to terminal 43. Going from terminal 42 to 43, the ground on arc 2 holds the OT relay operated, which

in turn extends the same ground to energize the STEP magnet, advancing the switch to terminal 44. The OT relay releases as the switch leaves terminal 43. With the OT relay released the ground on arc 2 is connected to the STEP magnet, advancing the switch to terminal 1. If the disconnect took place while the initial period was being timed, the circuit would advance as above to terminal 43 at which time the OT relay would operate through arc 2. The timing selector then operates through its interrupter contact and the OT relay contacts to move the switch to terminal 44. The OT relay releases as the switch leaves terminal 43 and the timing selector reoperates through terminal 44, the interrupter contact and the OT relay normal advancing the switch to terminal 1.

When the switch reaches position 1, the 300 ohm battery is connected to the BT lead, making the zone registration circuit available for another call. It will also operate the group busy circuit GB relay, if all other associated zone registration circuits are busy.

Zone registration circuit OT relay releases and the rotary switch returns to normal.

SELECTION OF ZONE REGISTRATION EQUIPMENT HAVING COMMON GROUP CONNECTORS - OS 343

For the purpose of this description Figs. 1, 2, 3, 4, 5, 6, 7 and 8 are used with "G" and "B" wiring.

Under certain situations only common zone registration circuits are used and no individuals exist. In this case common group connectors (Fig. 7) are used and no individual group connectors (Fig. 3) are provided.

Under other situations both individual and common zone registration circuits are used. In this case both individual group connectors (Fig. 3) and common group connectors (Fig. 7) are common to the control circuit (Fig. 4).

When both individual and common zone registration circuits are used, the circuit always prefers an individual circuit first and functions the same as described for individual group connectors. Only when all individual zone registration circuits are busy will the circuit prefer a common zone registration circuit.

When the last individual zone registration circuit of a group is selected for a call and the associated HD relay operates, the last ground is disconnected from the GB lead of the individual group busy circuit.

The group busy circuit GB relay releases due to all individual zone registration circuits being busy.

There is one Fig. 8 for each individual group and each common group of zone registration circuits associated with the zone equipment.

Individual group connector circuit GT relay operates.

When the next zone call starts in the group of district junctors associated with the individual group connectors having the GT relay operated, the district link frame ZS lead will cause the district connecting switch and the zone control to be selected. The ground connected to the ZS1 lead changes its functions due to the GT relay being operated.

Individual group connector circuit GT relay locks and the LL relay operates and locks in series from ground on the ZS1 lead from the district link frame LC relay operated.

When common group connectors are used, there is a Fig. A, B or C furnished for each individual group connector or connectors associated with the same zone control circuit (Fig. 4), having access to the same common group connector. The purpose of having the LL chain is to give preference to one zone control circuit and lock out all others, when more than one simultaneously prefer the common group of zone registration circuits. If two common groups of zone registration circuits are furnished, then two separate chains of LL relays are used.

Common group connector circuit TB relay operates from ground on the CC lead from the zone timing test circuit and in turn the common group connector CC relay operates.

The TB relay in operating connects the BT leads of the common zone registration circuits to the zone control S relays. It should be noted at this point that the BT leads of both the individual and common group connectors are connected in parallel at the zone control circuit. Only one group is effective at any one time, since only one or the other of the BT or TB relays can be operated.

From this point the circuit functions the same as already described, with the following exceptions: When the zone control HM relay operates the common group connector C relay operates. The reason for having the C relay is to connect the Z relay contacts to the TC relays of the common zone registration circuits. This is necessary because at times there will be TC relays operated at the same time for both an individual and common zone registration circuit which are common to one zone connector associated with one marker. When the HD relay operates, the individual group busy GBI relay operates and extends its operating ground to the ZL lead to the marker. This insures that the group is made busy until the TC relay has released.

On disconnection of the zone control circuit where a common group connector was involved, the GT relay may or may not release when ground is removed from the ZS1 lead. This depends upon whether an individual zone registration circuit has become idle, thereby operating the group busy circuit GB relay and removing battery from the secondary winding of the GT relay. Should this occur the GT relay releases and restores the individual group connector to service.

ALL INDIVIDUAL AND COMMON ZONE REGISTRATION CIRCUITS BUSY - OS 343

Should all individual and common zone registration circuits associated with one district link frame be busy, the GB relays for both groups will be released. The GT relay of the individual group connector will be operated.

When the next zone call originates on this district link frame, the circuit functions as described for common group connectors, up to the operation of the CC relay. No zone control circuit S relays will operate, since there are no idle common zone registration circuits. Therefore, the SE relay fails to operate. With the common group busy circuit GB relay released, the common group connector CC relay operated and the zone control SE relay released.

Zone control circuit CB relay operates and ground is connected to the traffic register circuit.

Ground is connected to the OF lead to the traffic register circuit, to score an overflow register.

Marker circuit ZO relay operates and ground is disconnected from the ZA lead to the zone equipment.

The district junctor TC relay operates and locks.

The TC relay locks when the subscriber's sender DRL relay operates.

With the TC relay operated, the district junctor circuit is set for a talking charge in which case the subscriber's message register is scored once for the call, should it finally be completed.

Under this condition, instead of delaying the call until an idle zone registration circuit becomes idle, the district junctor is set for the talking charge and perhaps results in an under-charge to the subscriber. This, of course, will rarely occur.

ALL TRUNKS BUSY - ZONE CHARGE CALL - OS 343

With "AT" wiring provided in the marker, the OV relay operates in series with the overflow route relay when all trunks in the original and alternate route groups are busy. Operation of the OV relay removes ground from the contact of the ZA to ZJ relays and also causes the NC1 relay to operate. The NC1 relay opens the locking circuit of any operated ZA1 to ZJ1 relay which in turn removes ground from the ZS lead to the zone registration equipment. This prevents unnecessary use of the zone registration circuits and permits connections to be made to overflow trunks on zone calls which might otherwise be blocked if the zone registration circuit failed to ground the ZL or ZCK leads.

TROUBLE INDICATOR FEATURE - OS 343

If the marker encounters a trouble condition on a zone call, it is desirable to indicate, if possible, the zone registration circuit involved. This is accomplished by the TI relay in Fig. 4 which is operated by the marker.

When the marker times out on a zone call and selects the trouble indicator, it operates its trouble indicator connecting relays. The operation of the connecting relay CIA connects ground to the ZR lead operating the zone control TI relay. The TI relay in operating connects ten trouble indicator relays, ZR0 to ZR9 to the contacts of the S0 to S9 relays of the zone control. One of these leads is grounded if a zone registration circuit has been selected to serve the call.

MAKE BUSY JACK FOR ZONE REGISTRATION CIRCUIT - OS 343

A make busy jack is furnished for each zone registration circuit, to permit its removal from service for maintenance reasons. The jack is arranged to avoid any drain while it is being used. Thus no relay operation occurs when the short-circuited plug is inserted in the MB jack, although the same indications are furnished to leads "BT" and "GB" as though the HD relay were actually operated.

ZONE CONTROL CIRCUIT-MAKE BUSY - OS 343

If it is desired to remove a zone control circuit (Fig. 4) from service, it is necessary to remove the associated district junctor circuits from service on the associated subscriber's sender link frame. This is done by inserting make busy plugs in the make busy jacks, so that the circuits will not be used in service.

CHAPTER 5

SECTION 7

MISCELLANEOUS INFORMATION AND FEATURES

Originating Marker Circuit	SD-25016-01
Trouble Indicator Circuit	SD-25018-01
District Junctor Circuit Noncoin	SD-25020-01
District Link and Connector Circuit	SD-25031-01
Office Link and Connector Circuit	SD-25033-01
Subscriber Recording and Completing Trunk Circuit	SD-25124-01
Permanent Signal Holding Trunk Circuit	SD-25126-01

MARCH 1954

TROUBLE INDICATOR CIRCUIT

CONNECTION TO TROUBLE INDICATOR - OS 342

A trouble indicator circuit is provided for a group of originating markers and is arranged for connection to any marker of the group that fails to complete its functions and release in a predetermined time. The time periods are measured by the marker circuits. The trouble indicator circuit takes a record of the call and restores the marker and its associated circuits.

When a marker circuit operates its DL relay due to timing out, or without counting time as in the case of all permanent signal trunks busy.

Marker circuit TR relay operates.

> Ground is connected to the MR lead to the trouble indicator frame to score a register.
>
> Ground is connected to the DB lead to hold the marker circuit busy.

The marker circuit places battery on the TIS lead causing the trouble indicator circuit DS relay associated with the marker to operate and lock if it is any relay except the first one.

> There is a DS relay in the trouble indicator circuit for each marker circuit which it serves. These relays are wired in double transfer chain in order to provide preference and prevent double connections. Two or more DS relays can operate simultaneously, but only one can cause its associated marker to be connected to the trouble indicator circuit.

The marker circuit places ground on the DL lead causing the trouble indicator circuit DL relay associated with the marker to operate and lock.

> Two or more DL relays can operate and lock in case of simultaneous calls from markers, or in case of calls while the trouble indicator is busy. Under these conditions they provide lamp signals to indicate the marker circuit which wereunsuccessful in connecting to the trouble indicator.

Ground is connected to the TIL lead to the miscellaneous circuit for the trouble indicator frame for sounding the trouble indicator alarm.

The trouble indicator circuit grounds the CIA lead causing the marker circuit CIA relay to operate.

> In case two or more DS relays are operated, the preference starts at the last one. The marker nearest to this relay consequently operates its CIA relay.

The trouble indicator circuit grounds the CO lead causing the marker circuit CO1 and CO3 relays to operate, this causes the transmitting leads to be disconnected from the windings of the XT and XT1 relays.

The marker grounds the TI lead causing the TI relay to operate in the district link and connector circuit.

> The district link and connector circuit TI relay is operated to prepare paths for taking a record of the district primary switch and the district primary switch select magnet operated for the call.

The marker circuit CIB, CIC, CID, CIE and CIF2 relays operate.

> The multicontact relays operated connect a number of leads to the trouble indicator circuit to record the progress of the call. Of the leads that are connected to the trouble indicator, those that are grounded operate corresponding relays.

OPERATION OF TROUBLE INDICATOR RECORDING RELAYS - OS 342

The CIA relay operated connects ground to the FRG, SNG and CNG leads to the marker connector circuit. These leads are closed through operated multicontact relays in the connector to the FR, SN and CN leads, respectively, to the trouble indicator. The trouble indicator circuit includes one CF relay for each connector frame installed, designated 0 to 9 or as required, 10 SN relays, designated 0 to 9, and 3 CN relays, designated 0 to 2. The FR, SN and CN leads, which are connected to the windings of the CF, SN and CN relays, are so arranged that one of each of these relays operates, indicating respectively the connector frame involved, the location of the sender in the connector, and the location of the connector on its frame.

The trouble indicator circuit also includes a maximum of twenty DF relays, designated 0 to 19 or as required, a maximum of ten OF relays, designated 0 to 9 or as required, and 15 TL relays, designated 0 to 14. The number of DF and OF relays installed is the same as the number of district frames and the number of pairs of office frames, respectively, and is consequently the same as the number of DF and O relays equipped in the markers. When the CIA relay operates it closes the DF, OK and TL leads to the trouble indicator, causing the DF, OF and TL relays corresponding to grounded leads to operate.

The CIA relay operated grounds the ZR lead to the zone registration and control circuit, operating the TI relay. The TI relay closes the ZR0 to 9 leads to the trouble indicator ZR0 to 9 relays, for purpose of indicating which one of the ten zone registration circuits was selected.

The CIF2 relay operated closes leads ZK, ZL, ZO, RL, MRL, RO, MR1, TB5, CRL, DT3 and AK from the marker to the trouble indicator circuit. These leads terminate at the windings of correspondingly designated relays in the trouble indicator, which operate if the leads are grounded. The CIF2 relay also closes the CK1, CK2, CK3 and CK4 leads but without effect as these leads are used only on test circuit calls.

The CIB relay closes 20 CH leads and 40 K leads from the windings of the twenty CH relays and from the windings of the 40 K relays to the windings of correspondingly designated relays in the trouble indicator. The trouble indicator relays corresponding to grounded leads operate.

The CIC relay closes the ZA1 to ZJ1, ZCK, TCK, TC1, OT1, NC1, PS1, XDF1, XSM1, GT3, GS1 to 4, JC0 to 19 and P0 to 13 leads to the trouble indicator, causing correspondingly designated relays to operate if the leads are grounded.

The CID relay closes X leads and miscellaneous leads, causing corresponding relays to operate if the leads are grounded.

The district link and connector circuit TI relay operated closes 10 M leads to the trouble indicator and causes one of 10 LC leads to be grounded, corresponding to the LC relay operated. A grounded M lead causes the corresponding M relay to operate, to indicate the district primary switch select magnet operated and grounded LC lead operates the corresponding SW relay, indicating the district link primary switch involved.

The CIE relay operated connects the receiving and transmitting leads to the windings of correspondingly designated relays in the trouble indicator, the leads that are grounded causing the corresponding relays to operate. The K4 and K5 leads, also closed by the CIE relay, are used to indicate whether or not the CK4 and CK5 relays have operated.

DISCONNECTION FROM THE MARKER - OS 342

The trouble indicator circuit is arranged to lock in the record and to disconnect from the marker, causing it to release its associated circuits and to restore. This takes place when the DR relay in the trouble indicator circuit operates due to the operated CID relay.

> The DR relay that operates corresponds to the marker circuit that is connected.

An additional ground is connected to the TIL lead to the miscellaneous circuit for the trouble indicator frame.

Trouble indicator circuit RT, RT1, HD, GD and GD1 relays operate and lock.

An additional ground is connected to the CIA lead to the marker.

Trouble indicator circuit RT and RT1 relays release.

> The slow operate RT1 relay and the slow release RT relay serve to time the period during which the recording relays operate before the marker is released.

Marker circuit CIA, CO1, CO3, CIF2, CIB, CIC, CID and CIE relays release.

District link and connector circuit TI relay releases.

Trouble indicator circuit RD and RM relays operate.

The TIB relay in all marker circuits operate from ground on the TIB leads from the trouble indicator circuit.

> The TIB relays operated in other markers cause them to send trouble release signals and to restore without waiting for the trouble indicator, if these circuits should also time out. In the circuit which is connected to the trouble indicator, the following takes place:

Ground is connected to the TRL lead.

> If failure had occurred in the decoding stage, the RX relay would still be operated and the TRL lead to the marker connector is grounded. If the failure was in the marker stage, the RX relay normal would cause the ground to be connected to the TRL lead of the district connector.

Marker circuit RL1 relay operates and the trouble indicator circuit DS relay for the marker releases.

> Operation of the RLI relay causes the marker to restore to normal.

DISPLAY OF RECORD - OS 342

Each recording relay operated in the trouble indicator prepares a path for lighting a lamp which is designated so as to identify the particular function associated with its recording lead in the marker; except that, in a few cases, operation of the recording relay opens the lighting circuit of the lamp, as it is necessary to use the absence of ground on the recording lead to indicate the operation of a relay in the marker.

In response to the trouble indicator alarm, the recorded information is displayed by operation of the trouble indicator circuit LP key, which locks and operates the LP and LP1 relays. The LP relays connects battery to all of the recording lamps, causing those which are grounded as a result of the operation, or nonoperation in some cases, of the recording relay to light.

The originating markers are arranged to decode a second call while completing the marker functions for a preceding call. Therefore, there may be one or two calls in the marker at the time the trouble indicator is summoned. When there are two calls, the one in the decoding stage can only summon the trouble indicator if the XX1 relay has been operated by the XOB, XOG, XSG, XCR or XCL relay, otherwise the selection of the indicator is delayed until after the preceding call in the marker stage has been completed. Thus, when the trouble indicator is summoned while two calls are being handled, only under the above conditions can the second call be responsible for its selection.

In this case, since the decoding relays operated for the first call have been released, and those required for the second call have been operated, the record taken will show the code, class of service and district frame information, the sender, marker connector and connector frame numbers, and the condition of the transmitting leads as applying to the second call rather than the first. If only one call is being handled and it encounters a trouble in the marker stage, this information will not be shown at all since the decoding relays have been released and not reoperated.

Whether one or two calls are being handled by the marker can be determined from the CKG and MS lamps. The trouble indicator circuit CKG relay operates and prepares a path for lighting its associated lamp if there is ground on the CKG lead of the marker, indicating that a sender is connected. The MS relay operates and prepares a path for lighting its associated lamp if there is ground on the MS lead of the marker (ST3 relay operated) indicating that a call is being handled in the marker stage.

LAMP INDICATIONS - RM 326

The lighted lamps in the trouble indicator circuit indicate the circuit conditions in the marker as follows:

> CKG lamp lighted and MS lamp out indicates that the marker connector is connected, that only one call is being handled by the marker, and that the trouble encountered by the marker is in the decoding stage.
>
> CKG lamp out and MS lamp lighted indicates that the marker connector has been disconnected, that only one call is being handled by the marker, and that the trouble encountered is in the marker stage.
>
> CKG and MS lamps both lighted indicates that a marker connector is connected, that two calls are being handled by the marker, and that the trouble encountered is in the first call in the marker stage.
>
> The lighted DR lamp indicates the marker circuit from which the record was taken. There is one of these lamps for each marker.
>
> Lighted DL lamps indicate markers that failed and were released without a record being taken, while the trouble indicator was busy. There is one of these lamps for each marker.
>
> The CF, CN and SN lamps indicate the connector frame, connector circuit and sender involved, if a sender is connected. One of each of these lamps lights.
>
> The A, B, C, D and F lamps lighted indicate corresponding grounded receiving leads. In each group, the numerical parts of the designations of the lighted lamps add up to the digit or class of service or frame number, except that falsely grounded or open receiving leads are indicated respectively, if all the lamps in certain groups are lighted, or

all lighted except one. For this purpose the lamps are grouped to correspond with the grouping of the receiving leads with respect to the check relays in the marker.

For example, a falsely grounded receiving lead not required for the call prevents the removal of ground from all the receiving leads to which the associated check lead is connected. Consequently in this case all the receiving leads associated with one of the marker check relays CK1, CK2 or CK3 remain grounded and the corresponding lamps remain lighted. There is no interference, however, with the removal of ground from the other two groups of leads.

An open receiving lead prevents the operation of one of relays CK1, CK2 or CK3 and consequently prevents the operation of one of relays CK4 or CK5. This in turn prevents the removal of ground from the associated leads. In this case the lamp for the open lead is not lighted and all the other lamps for leads associated with the CK4 relay or the CK5 relay are lighted. There is no interference, however, with the leads associated with the other relay.

The AR and OF lamps indicate second and third trials respectively, both lamps being lighted for a third trial. The AR indicates an alternate route and the OF indicates an overflow trunk. These lamps are grouped with the lamps for the A digit receiving leads and function as described above with respect to falsely grounded and open receiving leads.

The TP lamp indicates that a tip party had originated the call.

Transmitting lead lamps OB, SD, SD1, OG, SO, CR, CL and TW indicate the information transmitted to the sender by the marker for the particular code, each lighted lamp indicating that the corresponding transmitting lead is grounded.

The DF, OF, P, JC and TL lamps indicate respectively the district link and connector frame number as translated by the marker, the number of the office link and connector frame relay operated in the marker, the number of the P relay operated, the number of the JC relay operated, and the number of the TL relay operated.

Each OF lamp represents a pair of odd and even numbered office frames and if an even numbered trunk lamp (KEL-0 to KOR-9) is lighted, the even frame of the pair is the one on which the trunk is located. If an odd numbered trunk lamp is lighted, the trunk is located on the odd frame of the pair.

The JC relay which the JC lamp identifies must be determined with reference to the cross-connection information.

The M and SW lamps indicate respectively the district primary switch select magnet operated and the district link primary switch at which the district junctor involved in the call terminates. Together these lamps indicate the number of the district junctor circuit on the district link frame, the M lamp lighted representing the units digit of this number and the SW lamp the tens digit.

These indications are taken directly from the district link and connector circuit which is connected to the marker at the time the record is taken.

The CH lamps (L0 to R9) lighted indicates the CH relay operated in the marker and consequently the channel selected. The numerical part of the designation of the lamp is the same as the number of the district link secondary switch and the office link primary switch involved, and the left and right half switches correspond to the "L" and "R" lamp designations.

The K lamps (EL0 to OR9) lighted corresponds with the K relay operated in the marker. From this indication the office frame (even or odd) of the pair, the left or right half-switch on which the trunk is located (if the trunk level is split), and the office link secondary switch and consequently the primary switch level, can be determined. There are 40 of these lamps, one for each similarly designated K relay in the marker circuit.

The GS lamps indicates the route relay ground supply G and GS relays operated in the marker.

The G (0 to 11) lamps indicate the trunk subgroup relay operated in the marker. These lamps indicate directly the trunk subgroup for trunks divided into four or more subgroups. For trunk groups divided into two or three subgroups, any even number indicates the 0 group and any odd number indicates the 1 group.

The NM lamp indicates a key pulsing test call which does not require marker functions.

The ZS, Z, OT, TC, TP2 and XDK lamps indicate zone start lead closed, zone charge lead closed, operator talking lead closed, talking charge lead closed, tip party lead closed or false ground on DK or DK1 lead, respectively, during a test call.

The TM6 lamp indicates that the time out was by the interrupter timing and not by the condenser timed time-out.

The GT1 and GT3 lamps indicate respectively that the marker was blocked while associated with the first or second subgroups when the trunk group is divided into exactly two subgroups.

The TCK, TC1, OT1, NC1, PS1, ZA1 to ZJ1, ZCK, ZK, ZL, ZO, TPK, TP1 and RP1 lamps indicate that the circuits to operate the corresponding relays in the marker are closed.

The ZR (0 to 9) lamps indicate what zone registration circuit was selected.

The XOB, XOG, ~~SXG~~ XSG, XCR, XCL, XOF, XTL, XSS, XGS, XGE and XC lamps indicate that due to a false ground or a cross, two or more windings of relays in the corresponding group are energized or two or more relays in the group are operated.

The XDF1 lamp indicates a crossed contact on a marker DF- relay.

The XT lamp indicates that one or more transmitting leads to the sender are falsely grounded.

The XSL lamp indicates a false ground on the SL lead to the district link and connector circuit.

The XSM lamp indicates a falsely grounded or crossed SML or SMR lead to the office link and connector circuit.

The XSM1 lamp indicates two primary select magnets energized on the district frame.

The XK lamp indicates a false ground on the even or odd SP or NS leads or the PSA or PSB leads or the SSA or SSB leads or on the CK lead to the office link circuit or on the SSA, SSB or BK leads of the district link circuit.

The XTL1 lamp indicates a falsely grounded TL lead to the office link and connector circuit.

The XTC lamp indicates a false ground on the TC, TP or OT lead to the district link and connector circuit.

The XCH lamp indicates a false ground on the S or LS leads to the district link and connector circuit or on the LS leads to the office link and connector circuit.

The XLCE or XLCO lamp indicates a falsely grounded LC lead to the even or odd office link and connector circuit.

The XS lamp indicates a false ground on the S lead of the selected outgoing trunk.

The XS1 lamp indicates a falsely grounded S1 lead to the office link and connector circuit.

The XX1 lamp indicates that the master XX1 relay in the marker has operated.

The XZ lamp indicates that one of the zone charge leads ZA to ZJ is falsely grounded.

The XZS lamp indicates a false ground on the zone start lead ZS.

The XC lamp indicates that more than one of the group TC1, OT1, KP1, ZA1 to ZS1 relays were operated.

The XRL lamp indicates that the marker XRL relay has operated, due to a false ground on the RL or TRL lead. The XRL relay opens the circuit to the XDF1 lamp because the marker XRL locks the operated DF- relay which operates the XDF1 relay.

The XDC lamp indicates a false ground on the DC lead.

The SDT lamp indicates a falsely grounded ST or SDT lead of the sender test circuit connector circuit.

The K4 and K5 lamps indicate respectively that a satisfactory check of all the receiving leads associated with the CK4 and CK5 relays were grounded and that these relays were operated.

The SPE, SPO, NSE and NSO lamps indicate respectively the grounding of the corresponding leads in the marker.

The DK and AK lamps indicate respectively that the DK and AK leads to the district link and connector circuit were grounded.

The BK lamp indicates that the district link and connector circuit has grounded the BK lead and that the CK relay in the marker is operated.

The CK lamp indicates that the office link and connector circuit has grounded the CK lead.

The CHE lamp indicates that a channel has not been seized.

The TKE lamp indicates that an outgoing trunk was not seized.

The TK lamp indicates correct operation of the lettered transmitting relays for checking the transmitting leads required for the call.

The SR lamp indicates that the circuit to operate the SR relay in the marker is grounded. The SR relay operated sends a release signal to the connector.

? The A and C lamps are controlled by operated contacts of the A and C relays in the marker, provided that the AC1 relay is also operated. If one of these lamps is lit, the indication is that the associated relay is operated but that the other relay failed to operate because of a grounded or open lead. [If both lamps are out it does not mean that both relays have operated and then released because the operation of both these relays causes the AC1 relay to release and remove the ground from the operated contacts of the A and C relays and though either or both of these relays may fail to release, no lamp indications will be received.]

The S lamp indicates that the S lead of the selected trunk has been grounded by operation of the office secondary hold magnet and that the C relay in the marker has released.

The SL lamp indicates that the SL lead from the district link and connector circuit has been grounded by operation of the district primary hold magnet and that the A relay in the marker has released.

The B lamp indicates operation of the B relay in the marker. Unless trouble is encountered, this relay is shunted down by the release of the F relay in the district junctor circuit.

The MR lamp indicates operation of the MR relay in the marker and therefore that a satisfactory check of the MR lead was made. It also indicates that the marker AC relay has been released.

The SIK lamp indicates operation of the SIK relay in the marker and therefore the S1 lead of the selected trunk was grounded by operation of the office secondary hold magnet.

The MRL lamp indicates the operating circuit of the MRL relay was closed in the marker and that trouble was encountered by the marker circuit which prevented it from returning to normal.

The MR1 lamp indicates that the marker failed to release after encountering an open message register lead toward the district junctor.

The TB5 lamp indicates that the marker failed to return to normal after finding all trunks busy.

The CRL lamp indicates that the marker failed to return to normal after finding all channels busy.

The DT3 lamp indicates that the marker failed to return to normal after encountering a false ground or a panel selection make busy ground on the S1 lead of the selected trunk during the double connection test.

The RO lamp indicates that the marker failed to return to normal after transmitting a reorder signal to a key pulsing sender or a reorder on first or second trial call from subscriber sender.

The RL, TRL and EC lamps indicate a regular release, trouble release and end of cycle respectively, on test calls only.

RELEASE OF TROUBLE INDICATOR CIRCUIT - OS 342

To extinguish the lighted lamps and return the trouble indicator circuit to normal, the RL key is operated momentarily.

This causes the trouble indicator circuit KR relay to operate and any operated DL relays to release.

The lighted DL lamps are extinguished.

The operated DR relay in the trouble indicator circuit releases.

The corresponding DR lamp is extinguished. Ground is removed from the TIL lead to the miscellaneous circuit for the trouble indicator frame.

Trouble indicator circuit HD, KR, LP, LP1, GD1 and GD relays release.

The trouble indicator lamps are extinguished.

The operated trouble indicator circuit recording relays release.

The trouble indicator circuit RD and RM relays release.

The marker circuit TIB relays release in all markers.

TROUBLE INDICATOR MAKE BUSY - OS 342

A make busy jack, designated TIB, is provided in the trouble indicator for each associated marker, so that the trouble indicator may be made busy to any or all marker circuits as desired. These jacks are mounted on the trouble indicator frame. Insertion of a plug with the ring and sleeve strapped in one of these jacks connects ground to the TIB lead of the associated marker, thereby making the trouble indicator busy to that particular circuit.

DISTRICT LINK AND CONNECTOR CIRCUIT

SPECIAL CONDITIONS

REMOVING A PRIMARY SWITCH FROM SERVICE

In order to remove a district link primary switch from service, each of the ten district junctor circuits terminating at the switch must be made busy at the district junctor frame.

REMOVING A SECONDARY SWITCH FROM SERVICE - OS 335

Each district link and connector frame is equipped with ten MB jacks, designated 0 to 9, used for making the corresponding numbered secondary switches busy. Insertion of a plug with the tip, ring and sleeve strapped in one of these jacks opens the SSA or SSB lead from the ten select magnets of the corresponding secondary switch opens the LS leads of the twenty links which terminate at this switch and connects ground to these leads toward the marker. The ground connected to the LS leads causes a test busy condition during selection of a channel, by operating the associated marker AB- relay.

The left and right LS leads at any one of these MB jacks have the same numerical designation as the jack and the associated secondary switch. These leads are strapped at corresponding contacts of the ten LC relays for association with the primary switch verticals, in each switch, of the same number as the secondary switch involved. The SSA or SSB lead for the ten secondary select magnets also has the same numerical designation and is strapped at the LC relays.

The removal of a secondary switch from service effects only two links in each primary switch, these being the left and right links of the same number as the secondary switch.

MARKER LOCK-OUT AND CONTROL CIRCUIT - OS 326

As described for a regular call, there is an MP relay in the district link and connector circuit for each marker. These relays are wired in a chain circuit for preference in case of simultaneous calls from two or more markers and to prevent double connections.

Each district link and connector circuit also includes a corresponding set of E relays, wired to perform the same functions as the MP relays. The circuit is arranged for automatic throw-over to the E relays if trouble should develop in the MP relays, to prevent delay in the markers.

With all of the MP relays normal, the windings of the CH relay are energized from ground through the two chain circuits formed by normal contacts of the MP relays. Under these conditions the CH relay does not operate as it is differential. It operates only when one of its inductive windings is energized and not the other one, which would occur if one of the chain circuits remained open with the other one closed.

If one of the ground chains should be open, due to a trouble, with the MP relays normal or if an MP should operate and open only one of the chains the district link and connector circuit CH relay operates.

> The CH relay is slow operate to prevent its operation if one ground chain should be opened slightly before the other one is opened, in regular operation.

District link and connector circuit TR1 relay operates and locks followed by the operation and locking of the TR2, TR3, TR4 and TR5 relays.

The ST, MC and DK leads for all the markers are transferred from the MP relays to the E relays. Ground is connected to the CH lead for sounding an alarm and the CH lamp lights.

District link and connector circuit CH relay releases.

Operation of the TR2 relay disconnects the windings of the CH relay from the MP relays and connects them to the E relays. This causes the CH relay to release as both windings are energized.

The marker circuits can now continue to connect to the district frame, using the E relays. The alarm may be discontinued by operation of the locking type SA key.

Operation of the SA key extinguishes the CH lamp, removes ground from the CH lead and changes the locking path of the TR1 relay.

If the chain circuits should fail while the E relays are being used, the CH relay would operate as before and release the TR1 relay. This in turn would release the TR2 to TR5 relays, transferring the ST, MC and DK leads back to the MP relays, giving the alarm and lighting the CH lamp. In this case the alarm may be discontinued by releasing the SA key, which removes ground from the CH lead and extinguishes the CH lamp.

With either the MP relays or the E relays in use and with the SA key respectively normal or operated so that the alarm is not in operation, manual throw-over to the other set of relays may be accomplished by momentary operation of the nonlocking MTR key followed by operation or release of the SA key as required. The MTR key causes the CH relay to operate by opening the circuit through one of its windings. This causes the TR relays to operate or release as before, transferring the leads and giving the alarm. Subsequent operation or release of the SA key stops the alarm.

OFFICE LINK AND CONNECTOR CIRCUIT

SPECIAL CONDITIONS

REMOVING A PRIMARY SWITCH FROM SERVICE - OS 335

Each office link and connector frame is equipped with ten PMB jacks, designated 0 to 9, used for making the corresponding primary switches busy. Insertion of a plug with the tip, ring and sleeve strapped in one of these jacks opens the PA or PB lead from the ten select magnets of the corresponding primary switch, opens the LS leads of the twenty links connected to this switch and connects ground to these leads toward the marker. The ground connected to the LS leads causes a test busy condition during selection of a channel, by operating the associated marker C- relay.

The left and right LS leads at any one of these PMB jacks have the same numerical designation as the jack and the associated primary switch. These leads are strapped at corresponding contacts of the ten LC relays for association with the horizontals of the primary switch. The PA or PB lead for the ten primary select magnets also has the same numerical designation and is strapped at the LC relays.

REMOVING A SECONDARY SWITCH FROM SERVICE

Ten SMB jacks are provided for each office link frame and for each office extension frame, for making the secondary switches busy. Insertion of a plug with the tip, ring and sleeve strapped in one of these jacks opens one lead, either from the SA or SB, or the EA or EB lead of the ten select magnets of the corresponding secondary or extension switch, opens the S1 leads of the trunks connected to this switch and connects ground to these leads toward the marker. The ground connected to the S1 leads causes a test busy condition, during selection of a trunk, by operating the associated marker P- relay. The S1 leads of like number are multipled from the MCA relays to both the secondary and extension switches SMB jacks. Thus a plug in an SMB jack of either a secondary or extension switch will make the 10 trunks on both switches test busy.

The left and right S1 leads have the same numerical designation as the jack and the associated secondary switch. These leads are strapped at corresponding contacts of the TL and TR relays for connection to the secondary switch horizontals. The SA, SB, EA or EB lead for the ten secondary select magnets also has the same numerical designation and is strapped at the SS relays.

In addition, the outgoing trunks can be made busy at the outgoing trunk test board.

MARKER LOCK-OUT AND CONTROL CIRCUIT - OS 326

Each office link and connector frame has an MP relay for each marker, these relays being wired in a chain circuit for preference and to prevent double connections. The MP relays on the even numbered frame of each pair of frames are ordinarily used to control the marker connections to both frames. The MP relays on the odd frame, however, are automatically substituted for those on the even frame in case of trouble and can be substituted for them manually by the operation of keys, if desired, for maintenance purposes.

Each even numbered frame has a circuit per Fig. 7, which includes relays CH, TR1, TR2, TR3, TR4 and MB, and OMB jack, an MTR key and an SA key. Each odd numbered frame has a circuit per Fig. 16, which includes the CH, TR1, TR3, TR4 and MB relays, an OMB jack and an MTR key. All of this equipment on both frames is controlled as one circuit. It is separated so that, in case of fire, certain relays can be blocked to provide service.

Two CH relays are required on these frames because there are four chain circuits which are checked on these MP relays. The CH relays are differential and operate only when one inductive winding is energized and not the other. They are slow operate to prevent them from operating falsely if the circuit through one winding should be opened slightly before the other, in regular operation.

If one of the chain circuits remains open with the others closed the CH relay associated with the lead in trouble operates.

The TR1 relay on the even frame operates followed by the operation of the TR2, TR3 and TR4 relays and the TR1, TR3 and TR4 relays on the odd frame.

> The MCE, MCO, ST and SB leads for all markers are transferred from the MP relays on the even frame to the MP relays on the odd frame.
>
> Ground is connected to the CH lead for sounding an alarm and the CH lamp lights.

The operated CH relay releases.

> Operation of the TR2 relay disconnects the windings of the CH relays from the MP relays on the even frame and connects them to the MP relays on the odd frame. This causes the operated CH relay to release as both of its windings are energized.
>
> The marker circuits can now continue to connect to the office frames, using the MP relays on the odd frame. The alarm may be discontinued by operation of the locking type SA key.

Operation of the SA key extinguishes the CH lamp, removes ground from the CH lead and changes the locking path of the TR1 relay.

> If the chain circuits should fail while the MP relays on the odd frame are being used, one of the CH relays would operate as before and release the TR1 relay. This in turn would release the other TR relays, transferring the MCE, MCO, ST and SB leads back to the MP relays on the even frame, giving the alarm and lighting the CH lamp. In this case the alarm may be discontinued by releasing the SA key, which removes ground from the CH lead and extinguishes the CH lamp.
>
> With either set of MP relays in use and with the SA key either normal or operated as required so that the alarm is not in operation, manual throw-over to the other set of relays may be accomplished by momentary operation of the nonlocking MTR key on either frame, followed by operation or release of the SA key as required. The MTR key operated causes the associated CH relay to operate by opening the circuit through one of its windings. This causes the TR relays to operate or release as before, transferring the leads and giving the alarm. Subsequent operation or release of the SA key stops the alarm.

OFFICE FRAME MAKE BUSY - OS 327

To make an office frame busy, a plug with the tip, ring and sleeve strapped is inserted in the OMB jack.

If a plug is inserted in the OMB jack the office link and connector circuit **MB** relay operates.

> The operating ground for the MB relay of the mate frame is removed, the FB lamp lights, ground is connected to the MB lead to the mate frame, ground is connected to the FB lead for a visual signal that the frame is busy and the operating paths of the MCA relays on the frame that is made busy are opened.
>
> If it is necessary to make an office frame busy, the marker is arranged to operate satisfactorily despite the fact that the frame that is made busy cannot ground its NS or SP lead. The following operations apply when a nonsplit even frame of a pair is made busy.
>
> When a marker seizes the pair of frames, the MCA on the odd frame operates and closes ground from the operated MB relay on the even frame to the MB lead from the odd frame.

Marker circuit BE and all even numbered T relays operate.

> This makes all trunks on the even frame appear busy.

Marker circuit NSO and NSE relays operate.

> Ground on NSO lead through operated contacts of BE relay causes NSE relay to operate. This allows the PT relay to operate after the condenser timed interval and the call proceeds in the regular manner.

TRUNK "S" AND "S1" LEADS - OS 332

The reason for using two sleeve leads designated "S" and "S1" per out trunk is to permit the same trunks to be used in common with a panel unit, and also to permit a trunk to be made busy at the O.G.T. board without holding the various hold magnets operated. Both these leads extend to the marker for busy test, to guard against double connections in the event one of these leads should become open.

The use of a panel 3-wire office selector circuit must be limited to its selection of trunks that do not require the cut through of the district junctor and control of the subscriber's line by locking in the channel hold magnets.

DISTRICT JUNCTOR CIRCUIT, NONCOIN - OS 314

ONE-CHARGE CALL

A district junctor circuit is available for selection if it has battery through a resistance connected to the BT lead to the sender link and controller circuit. When a district junctor circuit is selected on acall, the sender link and controller circuit connects ground to the S lead, this causes the district junctor S1 relay to operate and open the BT lead.

With the BT lead open, the district junctor circuit tests busy at the associated sender link and controller circuit.

At this time the sender link and controller circuit also connects ground to the SC lead, which is connected in the district junctor to the S lead to the line link and controller circuit. This ground holds the line link hold magnets during the time that the sender is connected.

After the marker has been connected and has operated its route relay, the district link and connector frame associated with the district junctor frame involved in the call is connected to the marker. Ground is extended from the district link DK lead through the marker, the marker connector, the sender and the sender link and controller circuit to the DC lead to the district junctor circuit.

This causes the district junctor circuit F relay to operate.

The SL and S leads to the district link and connector circuit are connected, ground is connected to the M lead to the district link primary select magnet, the operating ground for the F relay is extended to the FC lead to the district link and connector circuit and the MR or MR1 lead from the district link and connector circuit is connected to the M1 lead to the line link and controller circuit.

In order to reduce the possibility of trouble due to an open message register lead, two such leads, designated MR and MR1, are provided between the markers and each group of ten district junctors. These leads are a bridge connected in the markers. The MR lead is wired to the first district junctor circuit of the group, and the MR1 lead to the last circuit, the ten circuits being strapped at this point.

The TRL lead from the district link and connector circuit is connected to the TR lead to the sender link and controller circuit.

District junctor circuit.

District junctor circuit TC relay operates and locks.

The TC relay operates from ground on the TC lead from the district link and connector circuit furnished by the marker, and locks to ground on the LR lead to the sender link and controller circuit furnished by the sender.

The ground on the LR lead is extended to the TC lead, to the marker, as a check on the TC relay locking circuit.

When the marker circuit sends a release signal to the sender, it provides a locking ground for the F relay on the FC lead, and then removes the operating ground which was connected to the DC lead.

This ground is removed after the district junctor circuit has been connected through to the selected trunk.

District junctor circuit F relay releases.

The S lead is disconnected from the SL lead, ground is removed from the M lead, the MR or MR1 lead is disconnected from the M1 lead, the TRL lead is disconnected from the TR lead, ground is connected to the S lead to the district link and connector circuit to hold the district and office hold magnets and ground is connected to the M1 lead to the line link and controller circuit to short-circuit the line message register.

Ground is connected to the M1 lead to prevent false operation of the message register due to battery crosses.

When the sender completes its part of the call and is about to restore to normal, it connects ground to the TR lead through the sender link and controller circuit to the district junctor.

District junctor circuit T relay operates and locks and ground is connected to the S lead to the line link and controller circuit.

This ground is used to hold the line link hold magnets during the conversation.

An additional locking path is closed for the TC relay and an additional ground is connected to the S lead to the district link and connector circuit.

The transmission circuit is closed, causing the S relay to operate over the calling subscriber's loop and with the CS relay connected in its nonoperate direction between the tip and ring leads to the district link and connector circuit. A holding path is closed for the S1 relay.

When the called subscriber answers, the polarity of the trunk is reversed and the district junctor CS relay operates.

Ground is connected to the A lead to the charge interrupter relay circuit.

Each group of twenty district junctors has associated with it two circuits per Fig. 3. In the first circuit, the relays are designated OB and OF, this circuit being associated with the odd numbered district primary switch of the two switches at which the twenty district junctor circuits appear. The other circuit includes relays designated EB and EF, and it is associated with the even numbered district primary switch of the two.

The OB and EB relays are arranged to be operated while the B contact of the associated CH interrupter is closed, and the OF and EF relays are operated while the F contact is closed. These relays release when the respective interrupter contacts open.

With ground on the A lead and with either the OB or EB relay operated the district junctor circuit I relay operates and locks.

If the CS relay is still operated by the time the OF or EF relay operates, the district junctor circuit CH relay operates and locks.

Ground is removed from the M1 lead and battery through a resistance is connected to the M1 lead, to score the line message register.

District junctor circuit TC relay releases.

The TC relay is slow release to allow sufficient time for the message register to score.

Battery is disconnected and ground is connected to the M1 lead.

The minimum time between operation of the CS relay when the called subscriber answers and operation of the CH relay for charging the call is approximately two seconds. The maximum time is five seconds. If the CS relay operates, but releases before the OF or EF relay operates for operating the CH relay, the subscriber is not charged. This circuit arrangement is used to prevent false charging on momentary operation of the CS relay as when the called line is busy or due to line disturbances.

When the called subscriber disconnects the polarity of the trunk is reversed and the district junctor circuit CS relay releases followed by the release of the I relay.

When the calling subscriber disconnects the district junctor circuit S and S1 relays release.

The S1 relay is slow release to guard against false release of the circuit if the S relay should release momentarily due to line surges or accidental momentary depression of the switchhook.

The CS relay releases at this time, if not already released.

Ground is removed from the S lead to the district link and connector circuit.

District junctor circuit T relay releases and ground is removed from the S lead to the line link and controller circuit.

The T relay is slow release to guard the sleeve of the outgoing trunk circuit for a brief interval after the S1 relay has opened the bridge across the trunk, so that the trunk will not be reselected for another call too early.

The removal of ground from the S lead to the line link and controller circuit by the release of the S1 relay causes the line link hold magnets to release.

District junctor circuit CH relay releases and ground is removed from the S lead to the district link and connector circuit.

Removal of this ground causes the district and office hold magnets to release.

Battery through resistance is connected to the BT lead to the sender link and controller circuit, causing the district junctor circuit to test idle.

NONCHARGE CALL

On a noncharge call, the circuit functions as described above, except that the marker does not operate the TC relay and consequently the message register does not score.

CALL TO AN OPERATOR

The circuit functions for a call to an operator as described for a call to a subscriber, except that the OT relay operates, instead of the TC relay. The OT relay locks to ground on the LR lead from the sender link and controller circuit and disconnects the S and CS relays from the tip and ring leads. The operators trunk L relay operates on sender trunk test which causes ground to be connected to the sleeve, thereby locking in all the hold magnets associated with the call. The district junctor T relay is then operated while the fundamental is still closed in the sender and locks to the sleeve ground. The T relay operated locks the OT relay and closes the calling subscriber through direct to the operators trunk, holding the trunk L relay.

As the CS relay cannot operate, the operation of the I and CH relays and the message register is omitted. The S1 relay will release when the sender link B hold magnet is released on the sender disconnecting. The T and OT relays are released on disconnection of the call when the operator removes the answering cord from the jack.

PREMATURE DISCONNECTION

If the calling subscriber disconnects before the sender has completed its functions and before the TC or OT relay has operated, battery through a resistance is connected to the LR lead by the sender, causing the I relay to operate. The I relay operated disconnects the SC lead to the sender link and controller circuit from the S lead to the line link and controller circuit, releasing the line link hold magnets and freeing the calling line. When the sender link restores, ground is removed from the S lead, releasing the S1 relay.

If the subscriber disconnects after the TC or OT relay has been operated, the sender removes ground from the LR lead, releasing the TC or OT relay. The sender then connects battery through resistance to the LR lead to operate the I relay.

SECOND TRIAL

If for any reason the marker circuit cannot establish a satisfactory connection between the district junctor circuit and a trunk circuit, it connects ground to the TRL lead through the district link and connector circuit and the district junctor circuit to the TR lead to the sender, as a trouble release signal. The sender circuit then removes ground from LR lead to release the TC or OT relays, if operated on the first trial. A second trial is then made, the sender proceeding to connect to a marker as for a new call. The subscriber's sender circuit, however, continues to hold the sender link, thus maintaining ground on the SC lead and holding the line link hold magnets operated.

AUTOMATIC RELEASE OF CALLING SUBSCRIBER

MIN. 112 SEC. TO MAX. 232 SEC.

If, after the completion of a charge call, the called subscriber disconnects and the calling subscriber does not, the calling line is released and the circuits restored after a time interval. In this case release of the CS relay, releasing the I relay and with the CH relay operated connects ground to the RF interrupter. With this ground connected when the F contact of the interrupter closes the district junctor circuit RL relay operates and locks.

When the B contact of the RB interrupter closes the district junctor circuit OT relay operates and locks.

> The OT relay operates in 1 minute 52 seconds minimum to 3 minutes 52 seconds maximum afterthe CS relay grounds the ST lead.

District junctor circuit S and T relays release, and ground is removed from the S lead to the line link and controller circuit.

District junctor circuit S1, CH, RL and OT relays release. Ground is removed from the S lead to the district link and connector circuit and battery through a resistance is connected to the BT lead to the sender link and controller circuit.

> Removal of ground from the S lead to the line link and controller circuit causes the line link hold magnets to release. The line is then connected to another sender as in regular operation and the call is routed as a permanent signal. The RL relay is slow release for the purpose of insuring the automatic release, should the called subscriber flash after the RL relay is operated. This is also the reason for two sets of interrupter contacts by using the RF and RB interrupters.

MAKE BUSY

When a plug is inserted in the MB jack, the BT lead to the sender link and controller circuit is opened, causing the circuit to test busy. Insertion of the plug while a call is going through does not interfere with the call.

PERMANENT SIGNAL HOLDING TRUNK

If a subscriber removes the receiver and fails to dial, leaving the receiver off the hook, or if a trouble develops on a subscriber's line which causes the equivalent condition, it is known as a permanent signal. The subscriber's sender is arranged to notify the originating marker of this condition. The marker then functions to route this type of call to a permanent signal holding trunk, which originates at the office link secondary switch multiple and terminates at the sender monitor position of the "A" switchboard or the sender make busy frame. A lamp is associated with the trunk so that its selection may be brought to the attention of the sender monitor operator; an answering jack is provided for challenging on and testing the line, and a holding key for preventing the release of the circuit.

When the subscriber's sender closes through its trunk test bridge across the T and R leads, the L relay of this circuit operates. Later when the district junctor T relay is operated, this L relay holds over the T and R leads through the short-circuit at the subscriber's line.

Trunk circuit L relay operates.

> The A and B ballast lamps are included in the L relay operating circuit in order to protect the relay from excessive heating should the subscriber's line be crossed with a foreign potential.

Trunk circuit L1 and L2 relays operate and ground is connected to the S lead to the office link secondary multiple.

> This ground is used to hold the connection that has been established through the district and office link frames.

Ground is connected to the S1 lead to the office link secondary multiple.

> This ground is provided to make the trunk appear busy at the office link secondary multiple. However, at this time it is ineffective as the operated office link secondary hold magnet has already connected ground to this lead.

Ground is connected to the PS lead to the auxiliary signal circuit.

> Ground on the PS lead causes the auxiliary signal circuit to function and light a panel lamp as an additional signal of the incoming call.

High tone is connected to ring of the line having the permanent signal and the trunk circuit lamp flashes slowly.

> The slowly flashing trunk lamp is a signal to the sender monitor operator that the trunk has been selected. She answers by inserting the plug of a cord into the ANS jack.

Trunk circuit CO relay operates and the L2 relay holds.

> The L2 relay is slow release to prevent the release of the trunk and the established connection in case of a momentary opening of the T or R lead. The slow release feature also prevents the above from occurring during the interval in which the L relay releases and before the CO relay is fully operated. The A condenser and resistance connected in parallel with the winding of the L2 relay aids in producing the slow release action at this time.

High tone is removed from ring side of line and the R lead from the office link secondary multiple is closed to the operator's cord circuit.

Trunk circuit L relay releases and the MB relay operates and locks.

> An additional ground is connected to the S and S1 leads to the office link secondary multiple.

Ground is removed from the PS lead and the trunk circuit lamp changes from a slow flash to a steady light.

> The operator may now challenge on the line and attempt to have it released at the calling end. If the subscriber disconnects, the operator removes the cord and the circuit restores.

Trunk circuit CO, L2, L1 and MB relay release.

> The L2 relay releases at this time because in this case the L relay does not reoperate over the subscriber's loop.

The trunk circuit lamp is extinguished and ground is removed from the S and S1 leads to the office link secondary multiple.

> Removal of this ground permits the operated hold magnets on the district and office link frames to release.
>
> If the operator removes the cord and the subscriber has not disconnected, the CO relay releases and the L relay reoperates over the subscriber's line loop, holding the L2 relay operated. This prevents the release of the circuit and the trunk lamp remains lighted steadily.
>
> The DS key is used to hold the circuit if the operator wishes to remove the cord after having been unsuccessful in attempting to cause the release of the line. When operated, it provides an additional locking ground for the MB relay. In this case, if the subscriber disconnects

after the operator has removed the cord, the L, L2 and L1 relays release and the MB relay remains operated, keeping ground connected to the S and S1 leads to the office link secondary multiple and the PS lead to the auxiliary signal circuit. The trunk circuit lamp flashes rapidly as a signal that the line is clear. Restoration of the key releases the MB relay, causing the trunk circuit to restore to normal and the established connection to be broken down.

This trunk circuit is arranged to connect a high tone to the ring conductor of any line to which it may be connected. This is provided for the identification of cable pairs at the main distributing frame which are affected by cable failure. There is a PS key located on the line choice connector frame, which when operated will cause the S relay to operate. The operation of the S relay causes high tone to be connected to the sleeve of the line also; thereby enabling line identification to be made at the line distributing frame. This feature is installed in case a cable failure should develop in which the ring conductors were grounded, shunting out the high tone that is applied to the ring.

TOLL DIVERSION

Refer to 200 series of OS's, RM 5-10

On certain dial P.B.X.'s the customers desire to restrict the dial extensions on the P.B.X. to calls that can be completed without the assistance of a central office or long distance operator. This restriction or diversion feature is provided on the outgoing service lines of the P.B.X.

The P.B.X. extension user wishing to make a call outside the P.B.X., after receiving dial tone from the local equipment, dials "9" and gets a trunk line to the central office from which point a second dial tone is received. The central office vertical associated with this trunk line has the T lead opened so that the central office line relay must operate to ground, supplied by the P.B.X. equipment, over the R side of the line.

The operation of central office line relay causes a sender to be connected to the trunk line at which time the second dial tone is received. The sender also supplies battery on the R side and ground on the tip. The P.B.X. equipment recognizes this battery and ground condition as a normal one and the dialing extension user can dial the call.

If the call is such that it can be completed on a talking charge or no charge basis, the sender is released and the district junctor is cut through. At this time the district junctor supplies a battery on the R side and ground on the T side which the P.B.X. continues to recognize as normal and permits the extension user to talk to the called party.

If the call was made to a "0" or LD operator, when the sender releases and the district junctor is cut through, the talking battery and ground of the district junctor is supplanted by battery and ground from the operator's trunk circuit.

This circuit provides battery onthe T side and ground on the R side which the P.B.X. recognizes as a reversed condition by the operation of the polarized TS relay in the P.B.X. equipment. The TS relay locks and causes the operation of the OP relay which opens the T and R lead to the central office equipment causing that connection to release. The dial extension on being cut off from the trunk line is connected to a special trunk to the P.B.X. attendant.

SUBSCRIBERS RECORDING COMPLETING TRUNK

The dialing of code 211 at a message rate station causes an idle recording completing trunk to be selected by the originating marker. This trunk originates at the office link secondary multiple and terminates at the long distance office in a lamp and jack arrangement. The relays comprising this trunk circuit are located on the miscellaneous relay bay and are connected between the office link secondary switches and the underground cable conductors.

When the office link secondary hold magnet operates and closes through to this trunk and the subscriber's sender closes its trunk test bridge the trunk circuit A relay operates.

> When the district junctor cuts through and the subscriber sender has disconnected, the A relay holds through the district junctor, under control of the calling subscriber. If the call was made from an extension of a P.B.X. that was arranged for toll diversion, the P.B.X. would at this time recognize that this was a restricted call and automatically release it.

Trunk circuit F and B relays operate and ground is connected to the S lead to the office link and connector circuit.

> This ground is used to lock the operated hold magnets of the established connection, thereby putting the connection under control of both the district junctor and this trunk circuit. This ground is connected through 5 ohms resistance so that it will not short-circuit the alternating current that passes over the S lead during number checking.

Trunk circuit C relay operates, ringing tone is connected to the calling subscriber's line, and the AC relay and AC condenser are bridged across the T and R leads to the long distance office.

Battery and ground through the windings of the NC and TK relays are connected to the T and R leads to the long distance office.

> This closure causes a high resistance relay at the long distance office to operate and light a line lamp. The TK and NC relays do not operate at this time, the TK because of the high resistance of the loop and the NC because the current through its windings is in its nonoperate direction.

The B relay is slow release to prevent the release of the operated hold magnets in case the subscriber should flash at this time or dial an extra digit.

Ground is connected to S1 lead of office link and connector circuit.

LONG DISTANCE OPERATOR ANSWERS

When the long distance operator answers, the resistance of the trunk loop is reduced at the long distance office, causing the trunk circuit TK and H relays to operate.

The H relay is slow release to hold over a false momentary release of the TK relay, which might occur due to line surges.

Ringing tone is disconnected from the calling subscriber's line, a holding path is closed for the B relay, the trunk circuit RV relay operates and locks and the talking circuit is closed through the B condenser.

The talking circuit through condenser B was left open until the operation of the RV relay to prevent false operation of the TK relay.

Trunk circuit A relay releases and reoperates.

The RV relay in operating causes the A relay to release and reoperate, and reverses the battery and ground to the calling subscriber.

The long distance operator may now respond to the calling subscriber and receive the order, the connection being completed while the subscriber remains on the line. After the calling line number is checked, the conversation between the subscribers takes place with the circuit built up as shown above.

RECALL BY SUBSCRIBER

If the calling subscriber wishes to recall the long distance operator, he may do so by flashing the receiver hook. This causes the A and F relays to release and reoperate, momentarily releasing the TK relay and reversing and restoring the polarity of the trunk to long distance. This causes a supervisory lamp at the long distance office to flash. The slow release characteristic of the H relay prevents the circuit from restoring to normal due to momentary release of the TK relay.

RECALL BY OPERATOR

It is assumed that the subscriber has disconnected, releasing the A and F relays, and that the operator wishes to recall him. This is done by the operation of a ringing key in the long distance operator's cord circuit which connects ringing current to the trunk, causing the trunk circuit AC relay to operate.

The TK and NC relays may vibrate from the ringing current at this time, but causes no other circuit operation, since the slow release H relay will hold operated on the vibrating contact of the TK relay until the operation of the SO relay provides a steady holding ground, and the NC1 relay is adjusted not to operate from the vibrating contact of the NC relay.

Trunk circuit SO relay operates.

Relay SO is slow acting in order to prevent its operation, if relay AC operates falsely on line surges at the time of the operation of the C relay.

The short circuit is removed from the B and C resistances and the 2-1 and 6-5 windings of the repeat coil are short-circuited.

The B and C resistances are introduced in series with the repeat coil windings at this time to prevent acoustic disturbances to the calling subscriber when the 2-1 and 6-5 windings of the repeat coil are short-circuited.

Trunk circuit RA relay operates.

The AC condenser and the AC, TK and NC relays are connected to the T and R leads of the trunk and are removed from the 1 and 2, 5 and 6 windings of the repeat coil.

The removal of the above condenser and relays from the repeat coil also removes the short circuit from the 1-2 and 5-6 terminals of the repeat coil. This is done at this time so that the 4-3 and 8-7 windings of the repeat coil may be of the highest possible inductance, and thereby provide a more efficient filtering of the ringing current upon the operation of the RB relay.

A holding path is closed for the RA relay and the short circuit is removed from the A resistance.

The removal of this short circuit places the A resistance in series with the A condenser. This is done to prevent damage to the contacts of the RB relay due to the sudden application of ringing current across the A condenser when the RB relay operates.

Trunk circuit RB relay operates, a holding path is closed for the RA and H relays and ringing current is connected to the calling subscribers line.

The ringing current connected to the subscriber's line is filtered by the 4-3 and 8-7 windings of the repeat coil and the A resistance and condenser. This filter circuit is supplied in order to avoid acoustic shock to the subscriber in case he answers while the ringing current is connected to the line, or in case the long distance operator rings accidentally while he is connected.

When the long distance operator releases the ringing key the trunk circuit AC and RB relays release, ringing current is disconnected from calling subscriber's line and the A relay operates.

If the subscriber has removed his receiver in answer to the re-ring, the A relay operates and performs the same function as mentioned above.

Trunk circuit RA relay releases.

The RA relay is held operated through its secondary winding until after the release of the RB relay in order to maintain the inductance of the repeat coil as high as possible until all disturbances incident to ringing on the line have been dissipated.

The A resistance is short-circuited, the AC, TK and NC relays are connected to the 1 and 2, 5 and 6 winding of of the repeat coil and the SO relay releases.

The SO relay is held through its secondary winding until after the release of the RA relay in order to maintain the connection of the B and C resistances in series with the repeat coil at the time that it is short-circuited, by connection of the signaling relays across it when the RA relay releases.

The B and C resistances are short-circuited and at this time the trunk circuit is restored to its normal talking position.

CHECKING THE CALLING SUBSCRIBER'S LINE NUMBER

On long distance calls completed as described above, the calling line number is checked by the long distance operator. To check the number, the long distance operator selects an idle trunk, known as an "Incoming Trunk Arranged for Number Checking", which terminates at the call distributing "B" board. The subscriber's number is passed to the "B" operator who keys the number on the "B" position key set, thereby registering it in a "B" sender. This sender through its associated terminating marker connector circuit passes the number to a terminating marker arranged for number checking. When the long distance operator selects an idle number checking trunk she also operates a key in the cord circuit connected to the recording completing trunk, which causes the NC relay to operate.

The arrangement at the long distance office end of this circuit is such that when the long distance operator connects to a number checking trunk and operates the cord circuit key, 48 volt battery is connected to the same side of the trunk as the 24 volt battery at this end of the circuit, regardless of the position of the F relay. The higher potential from the long distance office reverses the current through one winding of the NC relay causing it to operate. This relay is not affected by ground potential because its windings are connected so as to be parallel opposing to ground potential currents.

Trunk circuit NC1 relay operates, a holding path is closed for the H relay, the F relay is locked and the S lead from the office link and connector circuit is connected to the CT lead to the sleeve signal repeating circuit.

> The terminating marker used for the number checking call connects 135 cycle alternating current to the sleeve of the calling line. This current travels over the sleeve lead through the sleeve crosspoint at the primary line switch, through the sleeve of the established connection on the district and office link frames, to the sleeve of the recording completing trunk where it is connected to the CT lead to the sleeve signal repeating circuit, from which it is returned through the number checking trunk, and used to operate a relay in the terminating marker. Auto-transformer with the T and D condensers and the D resistance of this trunk circuit are provided as a filter to prevent false operation of the terminating marker relay on direct current surges from the S lead. The terminating marker causes the incoming number checking trunk circuit to function and return either an O.K. check or failure signal to the long distance operator.

DISCONNECTION OF NUMBER CHECKING RELAYS

After the number has been checked and the result of the check has been received by the long distance operator, she disconnects from the incoming number checking trunk and releases the cord circuit key. This causes the trunk circuit NC and NC1 relays to release.

> The CT lead is disconnected from the S lead to the office link and connector circuit.
>
> The circuit is now arranged for talking and conversation between the subscribers takes place at this time.

DISCONNECTION OF RECORDING COMPLETING TRUNK

When the calling subscriber disconnects the A and F relays release. When the long distance operator disconnects the recording completing trunk circuit the TK, H and B relays release and ground is removed from the S lead to the office link and connector circuit.

> Removal of this ground permits the operated hold magnet of the established connection to release.

Trunk circuit C and RV relays release.

> The C relay is slow release to prevent a reversal of the talking battery before the circuit to the subscriber's line is opened by the release of the office and district link hold magnets. This reversal would, in the case of a P.B.X. connection, cause the resignaling of the P.B.X. operator.

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CHAPTER 6

SECTION 1

PURPOSE, DESCRIPTION AND FUNCTIONS

Terminating Sender Link, Controller Circuit	SD-25459-01
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MARCH 1954

DESCRIPTION AND FUNCTIONS

GENERAL

This section covers the circuits of the incoming trunk, terminating sender link and control circuit, incoming link and terminating senders.

INCOMING TRUNK FRAME, 100 AND 160-TYPE

PURPOSE

The incoming trunk circuit used in conjunction with the terminating sender link and controller circuit and the terminating marker circuit, sets up the proper ringing, supervisory and transmission conditions. This trunk circuit is used for calls originating from either panel, manual, tandem or crossbar offices.

DESCRIPTION

The first frames encountered in handling incoming calls are those knows as the "Incoming Frame Group." Similar to the district frame group, they employ three frames: the terminating sender link frame on the left, incoming trunk frame, and the incoming link frame on the right. These three frames, link the district frame group, are always associated with each other as shown on RM 404.

INCOMING TRUNK FRAMES WITH 100 TRUNK INCOMING LINK FRAME

The incoming trunk frame is a two bay structure arranged for mounting relays and is located between the associated terminating sender link frame, on the left facing the front of the equipment, and the incoming link frame on the right. It mounts five incoming trunk units of twenty relay mounting plates each, spread over the two bays. Each unit has a capacity of twenty relay mounting plates each, spread over the two bays. Each unit has a capacity of twenty trunks or one trunk to a mounting plate. However, some types of trunks require two mounting plates, thereby preventing a unit from having its full complement of twenty trunks. In these cases a supplementary incoming trunk frame is provided and the remaining trunks of the unit are located on it. This frame is placed as near as possible to its associated incoming trunk frame. Self contained in each unit of twenty trunks are the terminal strip, resistance lamp strip, fuse panel and jack panel required for the unit.

In general, there are four classes of incoming trunks; full selector (crossbar, panel or tandem to crossbar), "B" switchboard, dial pulsing and multi-frequency. They furnish a means of completing calls from subscribers or operators to subscribers in the crossbar office.

Other incoming trunks are provided to gain access to subscribers' lines for number checking and testing, and to lines for message register testing. For "B" switchboard use, the full selector incoming trunk circuit is used with an auxiliary applique circuit when handling calls from manual offices. The trunk conductors are connected in and out of the auxiliary incoming trunk circuit, at the main distributing frame, to the full selector incoming trunk circuit. The relays for the auxiliary incoming trunk circuit are mounted in units of 10 on the miscellaneous relay rack.

The incoming trunks of a unit are divided into two groups of 10 trunks each. The ten trunks on the lower half of the unit appear on the horizontals of an even numbered incoming link primary switch of the associated incoming link frame. The ten trunks on the upper half appear on an odd switch. The zero or lowest unit on an incoming trunk frame is connected with primary switches zero and one of the incoming link frame. The number one or next higher unit is connected with primary switches two and three, etc. The trunk relays located on the left hand bay are for the even numbered trunks which appear as even horizontals while the trunks on the right hand bay are the odd trunks and appear on the odd horizontals. When a unit has its remaining trunks appearing on a supplementary frame because two mounting plates are required per trunk, these trunks are parts of the same two trunk groups into which the unit is divided. The incoming trunk frame can be said to have a nominal capacity of 100 trunks. RM 405.

Incoming trunks require access to full selector, dial pulsing, multi-frequency, or to "B" senders for the purpose of controlling the completion of calls in the crossbar office. In addition to appearing on the incoming link primary switches, the incoming trunks appear in groups of ten on horizontals of the associated terminating sender link frame primary switches. No group of ten trunks shall, however, include incomings requiring access to more than one type sender.

INCOMING TRUNK FRAMES WITH 160 TRUNK INCOMING LINK FRAME

When an office includes 160 trunk type incoming link frames, the incoming trunk frame as described above is known as the regular incoming trunk frame. The only changes from the above description of the incoming trunk frame for 100 trunk incoming links is the association of the incoming trunks with the incoming link frame. The incoming trunks on a regular incoming trunk frame are distributed in the same manner to the primary switches of the incoming link frame, as described above, except that each group of ten trunks to a primary switch are terminated in pairs, in horizontals Nos. 2 to 6. Therefore, horizontals Nos. 2 to 6 in each of the ten primary switches of an incoming link frame consititute the 100 incoming trunks appearing on the regular incoming trunk frame. RM 405, 406, and 407.

Supplementary incoming trunk frames are also associated with 160 trunk incoming link frames and are for the same purpose RM 408.

A third type of trunk frame is required with 160 trunk incoming link frames and is known as the auxiliary incoming trunk frame. Auxiliary trunk frames are identical in appearance and equipment as a regular incoming trunk frame. These frames provide for the additional 60 trunks appearing on the 160 trunk incoming link frame and which terminate on horizontals Nos. 7 to 9 in the primary switches of these frames. A unit of 20 trunks on an auxiliary incoming trunk frame will be spread in pairs over the 10 primary switches of the incoming link frame, the lower half of the unit appearing in switches Nos. 0 to 4 and the upper half appearing in switches Nos. 5 to 9.

Each auxiliary incoming trunk frame has an associated auxiliary terminating sender link frame, which in most cases will be serving trunks from two or more incoming link frames. The auxiliary incoming trunk frame and its associated terminating sender link frame is placed as near as possible to the incoming link frames having trunks connected.

Trunks requiring two mounting plates will not usually appear on auxiliary incoming trunk frames. Two plate trunks will be located on the regular incoming trunk frame and the supplemental incoming trunk frame. RM 408. Additional associated RM's are RM 409, 410, 411, and 412.

FUNCTIONS

The incoming trunk circuit recognizes selection and causes the terminating sender link controller to function and connect this trunk to an idle terminating sender.

It receives information from the terminating marker which it uses to determine whether ringing is required, which side of line ringing should be applied, whether call is to a free line, and whether overflow or line busy signals should be returned to calling subscriber.

The incoming trunk circuit provides supervision when the terminating subscriber answers and disconnects, and it recognizes disconnect by the calling party. It is arranged to automatically release the terminating connection if the calling party disconnects and the called party does not, after a predetermined time or in case the incoming trunk circuit has been reselected for another call.

The incoming trunk provides 48-volt bridged impedance transmission, except in certain cases where toll grade transmission is required such as key pulse toll incoming trunk circuits.

TERMINATING SENDER LINK FRAME

PURPOSE

The purpose of the terminating sender link frame is to attach an idle terminating sender to an incoming trunk for the handling of an incoming call. The action involved is similar to that which takes place in attaching a subscribers' sender to a calling line in the originating crossbar office.

DESCRIPTION

The terminating sender link frame is a single sided, single bay structure. It mounts a controller circuit, three 100 point 6 wire secondary switches, used for the sender multiple, and three 100 point 6 wire primary switches used for connecting the trunk groups. In addition there are two mounting plates containing 17 multi-contact relays and several terminal strips. The fuse panel is located at the top of the frame. RM 404.

This link frame has a capacity of thirty primary-secondary links which have access on the primary switches to 100 incoming trunks and on the secondary switches to a maximum of 60 senders in 6 subgroups of 10 each.

The incoming trunks appear as horizontals in the primary switches in groups of ten. RM 6-1, 413. The three primary switches are so wired as to accommodate ten groups of ten trunks each or one hundred trunks. Each primary switch has ten verticals making thirty verticals in all. In order that each of the ten trunk groups may have access to an even number of verticals or links, it is necessary to split the horizontal multiple after every third vertical and connect another group of 10 trunks. This arrangement gives each trunk group three verticals or links. Since the ten verticals of a switch will not divide evenly in groups of three, it is necessary to use verticals in adjacent switches for two of the ten groups. These groups are Nos. 3 and 4. The No. 3 group uses the first and second verticals of switch No. 1 and the first vertical of switch No. 0. The No. 4 group uses the third and fourth verticals of switch No. 1 and the fourth vertical of switch No. 2. The other verticals of the primary switches are then arranged in groups of three within the switches. The horizontal multiple of those verticals which are used for a group in adjacent switches are connected by local cable. The three primary switch verticals of each trunk group are numbered 0, 1 and 2, respectively.

This link frame may be equipped solely with one kind of incoming trunks or if desired it can serve a combination of the above four types of trunks, routing each to its own kind of sender. In cases where this link frame serves four kinds of traffic, the trunks are not mixed indiscriminately but are arranged in separate groups of ten. Consequently each link group (3 links) handles a particular kind of traffic, either full selector, "B" switchboard, dial pulsing or M-F key pulsing.

The link frame usually will have more than 2 types of incoming trunks associated with it and as a result requires 6 subgroups of senders. Provision for the 6 subgroups of senders is made by splitting the horizontal multiple of the secondary switches as required. Since one or two subgroups of senders appear on the horizontals of each secondary switch, this arrangement gives each trunk group access to each of three sender subgroups. A sender subgroup containing a maximum of ten senders can be composed of 2 types of senders. Although any link may then have access to two kinds of senders, it is permitted to make connection only with its own kind of sender. The kinds of senders within a subgroup of ten work independently of each other, except that momentarily one kind is held busy while a connection is being set up to the other. A subgroup of all the same type senders can be multipled to a maximum of twenty sender link frames. A subgroup composed of two types of senders is limited to a maximum of twelve sender link frames. RM 413.

One link consists of a primary and a secondary switch vertical wired together. Inasmuch as the primary and secondary switches are six wire switches this link is a six wire link. However, the incoming trunk which is wired to the horizontal of the primary, uses only five of the six crosspoint contacts. The sixth lead, designated S, is connected from the sender to the secondary switch and is extended through the link to the primary switch crosspoints. This lead is not closed through the primary crosspoints but is wired back into the controller circuit to aid it in its functions. The link spread is a vertical to vertical spread and is arranged in such a manner that the number of the trunk group on the primary switches becomes the number of the vertical on the secondary switches, and the number of the primary vertical (0, 1 or 2) becomes the number of the secondary switch or sender subgroup in which the link terminates.

From the above it can be seen that the thirty primary verticals are connected to the thirty secondary verticals and that one such connection is used to associate a trunk with a sender. It can also be seen from the link spread, that each trunk group, by its three links, has access to three sender subgroups consisting of the proper type senders to serve the call.

The controller circuit of the terminating sender link frame works on a mate frame basis, that is, the controller circuit for one frame acts as an emergency controller circuit for another frame, called its mate, and vice versa. An emergency controller circuit is provided to function when an odd number of link frames is supplied. A controller circuit working with its own frame is said to be operating on a home basis, while a controller circuit working with its mate frame is said to be operating on a mate frame basis.

There is one sender subgroup circuit required for each subgroup of ten or less senders. These units are located on the miscellaneous frames in three groups in order to lessen the hazard due to a bay of equipment being rendered inoperative.

FUNCTIONS

The terminating sender link controller circuit is arranged to recognize an incoming trunk group containing a call, if that trunk group has at least one path available to an idle terminating sender of the type required by the trunks in this trunk group. In case of simultaneous calls, it is arranged to serve them in a definite order and permit only one call in each group containing waiting calls to be served before it will permit a second call in any group to be served.

The controller chooses one of the available subgroups of senders in accordance with a fixed preference and to lock other terminating sender link control circuits out of the chosen sender subgroup. If the preferred sender subgroup does not have at least two idle senders, it will choose another subgroup, but if it fails to find one with two idle senders it will retest and select one with only one sender available. Also it will shift the preference to another sender subgroup in case the preferred one is busy to another terminating sender link controller circuit. Having chosen the sender subgroup, it will prefer a certain sender in that subgroup if it is idle; otherwise, it will select another sender which is idle.

The controller with the aid of the incoming trunk closes the crosspoints connecting the incoming trunk to the chosen terminating sender.

When two office units are served by the same terminating equipment, some means must be used to determine which office unit the call should be completed to. At present, there are two ways of accomplishing this. One method is to notify the terminating sender that the call is for office unit A by giving no indication, and for office unit B by adding 5 pulses to the incoming group selection. The second method is to have the terminating sender link frame determine, from the incoming trunk handling the call, which office unit this particular trunk has access to, then, to notify the terminating sender that the call is for office unit A or for office unit B.

The first method would necessitate modification of all existing panel subscriber senders; thus, this system will not be used in Cleveland, at present, except between crossbar offices where the originating senders will be equipped for sending five additional pulses in incoming group selection when required. By using this method a considerable saving may be made by having only one common trunk group between one office exchange and another exchange consisting of two office units.

The terminating sender link is, therefore, arranged to indicate to the terminating sender by grounding an (OA) office indication lead if the call is for office unit A, or by grounding an (OB) lead for office unit B. The incoming trunk group gives this indication; thus, all ten incoming trunk circuits within a trunk group must be for the same office unit. If a common group of trunks is used, the terminating sender link incoming trunk group relay will indicate the call is for office unit A and the terminating sender will then receive the indication direct from the originating crossbar sender if the call is for unit B; thus, it may be seen that we can have a combination of the two methods for giving office unit indication to the terminating sender.

The terminating sender link frame is arranged to give an alarm whenever a call is not completed in the normal manner and to place all subsequent calls in the mate controller.

TERMINATING SENDER FRAME

PURPOSE

The purpose of the terminating sender frame is to provide the equipment necessary for receiving information from the originating subscriber sender, key pulse sender, or from dialing trunk and passing information to the terminating marker for the completion of the call.

DESCRIPTION

TERMINATING FULL SELECTOR AND "B" SENDER FRAME

The terminating full selector and "B" sender frame is a single sided single bay structure mounting five sender units. See FM 6-2. The sender frames are numbered from zero up in the office and each sender unit is numbered from zero to four on each sender frame. Two "B" sender units, occupying positions zero and one, are the maximum of this type that may be located on any one frame. Full selector senders occupy the remaining positions. The "B" sender units may be replaced by full selector sender units without changing the local cable whenever it is desired to convert to dial operation.

The senders mounted on two sender frames usually constitute a subgroup of 10 senders, and all the senders in a number of such subgroups are used in common to function with all the incoming trunks and associated terminating sender link frames in the office. The total number of senders which can be used in one large group is limited by the fact that they are arranged to function with a maximum of twenty incoming frames. Only one such large group can be used with one group of terminating markers.

The ten senders of a subgroup may consist partly of full selector senders and partly of "B" senders. In these cases the subgroup is subdivided into two subgroups, one full selector and one "B" sender subgroup. Although any link has access to two types of senders it is permitted to make connection with its own type only by the arrangement of cross connections in the sender subgroup circuit as described later.

Each subgroup of senders is connected to each of the terminating sender link and controller circuits which it serves by 19 leads, which are connected into any one individual sender for a short time when it is first seized. These are the GS, SL, RL and TR leads which assist the controller circuit in its functions, twelve F leads for registering in the sender the number of the incoming frame, the EF lead which is used when the frame number is an even number, and the OA and OB leads which are used for office identification.

Each sender is individually connected to the terminating sender link and controller circuit by nine leads, of which six appear at the crosspoints of the sender link secondary switches. These six leads are designated T, R, D, CO, S and FC. The other three individual leads are designated SB, BS and SC.

There are 34 leads from each full selector sender to its terminating marker connector circuit, used for transmitting information from the sender to the terminating marker.

FUNCTIONS

When the interoffice trunk to a crossbar office is seized in the originating office and the associated subscriber sender is ready for incoming selections, the incoming trunk circuit in the crossbar office grounds its start lead to the terminating sender link controller.

This ground will cause the group start equipment serving the group of ten incoming trunks in which the selected trunk appears to seize either the home or mate terminating sender link controller. The controller, in conjunction with the sender selector equipment, proceeds to select an idle full selector or dialing sender, depending on which type of sender is required for this group of trunks. The selected sender is then connected to the incoming trunk through an idle sender link and is given an indication as to the number of the incoming link frame on which the trunk appears.

When the connection to a full selector sender has been completed through the terminating sender link frame, a path is provided from the originating sender over the interoffice trunk and through the terminating sender link switches to the full selector terminating sender. The full selector sender receiver the called number from the originating sender by sending revertive pulses simulating the pulses sent back from the commutators of incoming and final selectors in a panel office. Even though the originating sender is in a crossbar office, the number is not received by the full selector sender as the four digits set up on the register switch in the originating sender but as incoming brush, incoming group, final brush, final tens, and final units selection.

This method is used so that originating and full selector crossbar senders may function on calls to either panel or crossbar offices with a minimum of additional equipment and with no change in the present panel equipment. The above selections are registered on the verticals of the crossbar switch, after which trunk closure by the district junctor causes the sender to connect itself to a terminating marker through a terminating marker connector frame and transfers the called number to the marker. The marker then proceeds to connect the incoming trunk, on which the call is waiting, to the called line and to release itself and the sender.

The terminating sender receives information from the terminating sender link or from terminating sender link and originating sender, to determine which office unit the call is to be completed to, which it then passes on to the terminating marker.

The functions of the terminating sender, in general, are as follows:

a. To register the number of the incoming link frame and transmit the number to the terminating marker.

b. To receive, from the originating sender or terminating sender link office, "A" or "B" indication and transmit this information to the terminating marker.

c. To receive from the originating sender the telephone number of the called line and transmit this information to the terminating marker.

d. To seize a terminating marker.

e. To provide a path between the terminating marker and incoming trunk for control in setting up a connection to the called line.

f. To indicate a special terminating marker when required.

g. To receive a release signal from the terminating marker.

To summarize the equipment operations so far, we may say: See RM 012 and 013.

A trunk is selected by an operator, a panel district or office selector circuit, or by a crossbar originating marker circuit.

Upon the selection of an incoming trunk at a panel or crossbar office and upon the advance of the originating sender to incoming brush selection, the incoming trunk circuit functions to ground a start lead to the terminating sender link and controller circuit.

The controller circuit selects the calling trunk and an idle terminating sender after which the terminating sender is connected by link to the calling trunk and originating sender.

The number of the incoming link frame having the calling trunk is then registered in the terminating sender and the controller circuit released.

Incoming and final selections are transmitted from the originating sender to the terminating sender by revertive pulsing. After the pulses necessary to satisfy the originating sender are generated and counted, and registered on a crossbar switch in the terminating sender, a reverse battery and ground signal is sent to the originating sender. This reverse battery causes the originating equipment to advance for trunk closure.

After the incoming receives trunk closure, a terminating marker is attached to the terminating sender by means of a terminating marker connector circuit. The selections registered on the terminating sender crossbar switch are transferred as a number to the terminating marker which connects the incoming trunk, appearing as a horizontal on the incoming link frame, to the called subscriber's line. After having set up the correct ringing condition in the incoming trunk circuit, the terminating marker releases the terminating sender, which, in turn, releases the terminating marker connector and the sender link involved.

The established connection is held under control of the subscriber or operator at the originating office and the called subscriber and is released when they disconnect.

CHAPTER 6

SECTION 2

METHOD OF OPERATION

Terminating Sender Link and Controller Circuit SD-25459-01

MARCH 1954

START OF CALL OS 401-1

The terminating call which we are concerned with may have been originated by:

a. A subscriber in the same or another crossbar office.

b. A subscriber in a panel dial central office.

c. A toll operator which completes calls on a key pulsing basis. This trunk might be arranged to re-ring the called subscriber or arranged for coin control operation.

d. A tandem operator who completes calls on a key pulsing basis.

e. A crossbar dial system "A" operator who completes calls on a key pulsing basis. The trunk may be one to complete calls on a "no-test" basis.

f. A local test desk testboardman who wishes to connect to a particular subscriber's line for testing purposes. This trunk may be one arranged to connect to a line regardless of busy condition ("no-test") or arranged to cancel P.B.X. trunk hunting ("no-hunt"), or one which cancels the "no-test" and "no-hunt" features ("no-nothing").

From the above, it may be seen that there are many different types of incoming trunk circuits which are still further increased by the various ringing conditions and type of transmission required. Inasmuch as the majority of incoming trunks to crossbar offices will be from panel or crossbar offices, and both of these use the same incoming trunk circuit, we will limit our detailed description to this type of incoming trunk circuit.

When an interoffice trunk is seized in the originating panel or crossbar office and the dialing has progressed far enough, the originating sender makes trunk test. The purpose of trunk test is to absorb any electrical charge that might be on the trunk cable which might falsely operate the originating sender (STP) relay. The trunk test loop contains a 14,500 ohm resistance which is inserted to prevent the premature operation of the incoming trunk circuit line relay.

When the panel or tandem selector advances to its selection beyond position, or the office link secondary hold magnet is operated, battery through the incoming trunk A relay winding and ground from the normal contacts of the incoming trunk D relay are used to satisfy the originating sender for its trunk guard test. The battery side of the A relay has an inductive and non-inductive winding in parallel to improve operating conditions for the originating sender STP relay.

The A relay does not operate when the originating sender is making trunk guard test due to a high resistance being included in the fundamental circuit at the originating sender. When the originating sender advances to its incoming brush selection position it removes this high resistance causing the following to occur:

Incoming trunk circuit A relay operates.

The originating sender STP relay operates in series with the incoming trunk circuit A relay.

Ground is connected to the ST lead to the terminating sender link and controller circuit.

SEIZURE OF TERMINATING SENDER LINK AND CONTROLLER CIRCUIT OS 401

In the terminating sender link and controller circuit there are ten group circuits, one for each group of ten incoming trunks. Only trunks requiring the service of the same kind of sender may be placed in the same trunk group. Each group circuit is comprised of ten incoming trunk ST leads, one for each trunk in the group, which are bunched together through the normal contacts of the group circuit G relay.

When ground is connected to the ST lead from the incoming trunk under the above condition, the following occurs:

Group circuit GST-relay operates and locks.

There are ten GST relays designated 0 to 9 on a terminating sender link frame, one for each group of ten trunks. Each GST relay can be operated from any one of ten start leads within the group.

The GST relay locks through the normal contacts of the associated G relay. The GST relay is slow operate to prevent false starts should the incoming trunk A relay operate momentarily due to a line surge.

START CIRCUIT OS 401

There are two start leads designated STA and STB from each group circuit to a common start circuit. The common start circuit tests, by means of the PA and STA and STB leads, all of which are connected together as described in the following, to determine whether or not there is at least one idle link of the three links serving a trunk group, with its associated sender subgroup having at least one of the required type of senders idle before accepting a call from the group of trunks.

For the purpose of the description that follows, it is assumed that the terminating sender link frame is a combination frame having all four kinds of senders.

Each primary switch hold magnet is equipped with a pair of off normal contacts. The No. 4 contact of each primary hold magnet is connected to ground and the No. 3 contact, at which the PA lead originates is connected to a contact at the AMB or BMB relay of the sender subgroup connector circuit associated with the subgroup of senders to which the link has access. There is a connector circuit for each subgroup of senders appearing at a terminating sender link frame, or six such circuits on a frame. Therefore, each PA lead of the three primary hold magnets associated with one group of trunks will be connected to its respective AMB or BMB relay in the three associated sender subgroup connector circuits on the frame. The PA lead at the AMB or BMB relay to which each PA lead from the link connects, corresponds to the number of the incoming trunk group served by the links. RM 415.

The AMB relay is used in connection with the first kind of senders in the subgroup and the BMB relay is used in connection with the second kind.

The PA leads of the corresponding armatures of the three associated AMB relays located on one frame are multipled together. The same is true of the BMB relays. When a trunk group requires the use of a third and fourth kind of sender, the PA leads from the primary hold magnets are wired to contacts of a second group of three AMB or BMB relays. The trunk group indicates to the sender link which group of AMB or BMB relays are required to be tested for a particular call.

Common to these groups of AMB and BMB relays are ten PA leads designated 0 to 9, one from each of the ten group circuits GST and TG relays. If the incoming trunks in the group require full selector senders, the "Q" wiring is connected to the PA lead of the associated group circuit and the AMB relays of the group have control. If "B" senders are required then "V" wiring is connected and the BMB relays of the group have control. Only one or the other of the "Q" or "V" wiring can be connected to any one group circuit. By this arrangement the PA leads of certain trunk groups are tested through one group of AMB and BMB relays while the remaining trunk groups are tested through a second group of AMB and BMB relays. (See RM 415.)

The trunk group must also indicate that it requires the first group of AMB or BMB relays which it does by causing the "G" wiring at the TG relay to operate the SC-1 relay. If the trunk group had required the use of an M-F key pulsing or dial pulse sender it's "G" wiring would cause the SC-2 relay to operate.

The purpose of the above arrangement is to indicate two circuit conditions. The first is to indicate by ground on the PA lead at the group circuit that some one of the three links associated with the trunk group is idle. The second is to make it possible to disconnect any one of the three possible grounds from the PA lead at the group circuit, when the sender subgroup to which the link has access is busy, by the operation of the AMB or BMB relay.

For this call, it is assumed that all links and sender subgroups are available, therefore, ground is present on the PA lead of each group circuit.

A start circuit GA and a GB-relay operate and lock in parallel.

There are ten GA and ten GB relays, designated 0 to 9. The number of the operated GA and GB relays corresponds to the number of the trunk group originating the call, and more than one may operate and lock simultaneously.

Should all three link hold magnets associated with one group of trunks be operated when the GST relay operates, its associated GA and GB relay can not operate. This arrangement prevents the start circuit from being blocked to other calls when links are not available in any trunk group which has started a call.

Start circuit CA relay operates and locks. OS 402

The CB relay attempts to operate but being slow does not fully operate as its operating path is opened by the faster operating CA relay. The CA and CB relays are arranged in a chain circuit and the CB relay is made slow operate in order to cause each frame normally to prefer its home controller circuit.

CONNECTION OF CONTROLLER CIRCUIT OS 402

Controller connector circuit H and HC relays operate.

The H and HC relays are multi-contact relays used for connecting the controller circuit to its home frame, while the M and MC relays connect this frame to its mate controller circuit.

Start circuit GTA relay operates

The operating paths for all GA relays are opened.

The GTA relay is commonly referred to as a gate relay. When operated it prevents any additional trunk groups from placing a call in the start circuit until those that are locked in at this time are cared for.

TRUNK GROUP SELECTION

This circuit has now advanced to a point where it is necessary to connect to the trunk group originating the call, or the preferred trunk group in case of simultaneous connections.

A call that has originated may back out prior to the operation of the HC relay. However, once the HC relay has operated, the GA relay can not release, and an abandoned call must time out as described later. Therefore, the lowest numbered operated GA relay that has previously been locked by the operation of the HC relay is the one that has preference. The GTA relay in operating prevents any other GA relays from operating, thereby, preventing the preference from being changed.

Group circuit TG relay operates.

The TG relay is one-half of a multi-contact relay. There are ten TG relays (five multi-contact relays,) located on a terminating sender link frame, one for each trunk group, numbered to correspond to the associated trunk groups. Inasmuch as trunks requiring the same type of sender are in the same trunk group and this link frame can connect to four kinds of senders, it is necessary for each TG relay to indicate the kind of sender required. The senders are divided into 6 subgroups. The first and third kinds of senders are controlled by relays AMB, ASG, AGB and GAT while the second and fourth kinds are controlled by relays BMB, BSG, BGB and GBT. The separation of the different kinds of senders is made by locating them in different groups of horizontals and on opposite sides of the split in the secondary switch horizontal multiple. (See RM 6-1.) The "G" wiring of each TG relay will operate either the SC-1 or SC-2 relay which in turn directs the choice of senders to either the left or the right section of the secondary switch, respectively. The "Q" or "V" wiring of each TG relay will determine whether the senders required are the ones connected to the lower horizontals or the upper horizontals of a particular left or right section of the secondary switch.

This call is from a panel, crossbar or full selector tandem office and requires a full selector terminating sender. This TG relay will operate the SC-1 and the ASG relays to gain access to the proper senders.

The TG relay that operates corresponds in number to the lowest numbered operated GA relay. From the operation of the TG relay there are two series of operations occurring simultaneously, namely sender subgroup test and incoming trunk selection, of which sender subgroup test is considered first.

SENDER SUBGROUP TEST

Before selecting the sender subgroup to be used for this call a test is made to determine the availability of the sender subgroups and their associated links. There are two types of sender subgroup tests, regular and reserve. The regular test determines whether there is at least one normal primary hold magnet, or idle link, of the three links associated with the trunk group; whether the subgroup of senders that this idle link has access to, has at least two available senders; and whether the sender subgroup circuit for this subgroup of senders is not being used by another sender link frame. The reserve test only functions after an attempt has failed to operate on a regular basis and provided that there is a subgroup of senders with one sender and its associated link idle. The details of reserve testing will be covered later. The above means of first using the sender subgroup having more than one idle sender distributes the load on the sender subgroups of a frame, and reduces the probability of blocking calls when there are idle links on the frame that can not be associated with idle senders.

As has been explained, the link spread is such that there are three links for each trunk group, one link for each of the three sender subgroups. A subgroup of senders appearing at a sender link frame, therefore, has ten links that have access to it, one link for each of the ten trunk groups on that frame. A combined subgroup of two kinds of senders may multiple to a maximum of 12 sender link frames, while a straight group of senders may multiple to a maximum of 20 sender link frames. This multipling of the senders of a subgroup allows the senders of such a subgroup to be used by the trunk groups of all the sender link frames on which the sender subgroup appears. Should all the senders of a sender subgroup be busy, the associated links of the busy sender subgroup on all the sender link frames where this sender subgroup appears would be made unavailable to service, by the operation of the AMB or BMB relays.RM 414.

Therefore, it is desirable to attempt to place calls, in the sender subgroup having at least two idle senders rather than overloading a subgroup to the extent of using all the senders in it before placing calls in other subgroups. By employing this method the hazard of rendering links unavailable to service is greatly reduced. Calls are not placed in a subgroup having only one sender available until all subgroups appearing on the same sender link frame have reached the same condition.

The switchover from regular to reserve test is accomplished by the SR relay, which is slow release in order to allow sufficient time for regular sender group test to be completed and for the condition of some sender subgroup to change to two senders available before proceeding with reserve sender test.

REGULAR SENDER SUBGROUP TEST OS 403

When the TG relay operated, three SG leads designated 0 to 2 were closed through to test the three subgroups of senders, required by the trunk group, to determine which subgroups had two or more idle senders.

Controller circuit SC-1 relay operates.

> The SC-1 relay in operating indicates that sender subgroups to be tested are on left section of the secondary switches.

Controller circuit ASG relay operates.

> The ASG relay in operating indicates that sender subgroups to be tested are on lower horizontals of the secondary switches.

Controller circuit SG-0 to SG-2 relays operate OS 406

> One or more SG relays may operate if the trunk group originating the call has idle links to sender subgroups which have two or more idle senders.

INCOMING TRUNK SELECTION OS 404

The contacts of the operated TG relay close through the start leads from the ten trunks of the selected group to the windings of the ten controller circuit T relays designated T-0 to T-9. Since the start leads of all ten trunks are bunched at the contacts of the G relay, the ground on the ST lead of any calling trunk causes ground to be placed on all start leads of the group to the controller circuit causing the following:

Controller circuit relays T-0 to T-9 operate.

The T-0 relay locks around the contacts of the controller circuit TE relay.

Controller circuit TC relay operates and locks.

The ground for operating the TC relay comes over the PA lead. This is a check to insure that there are still idle senders available before continuing trunk selection and tying up too much equipment. The reason for this will be explained in detail later.

Controller circuit TT relay operates and locks.

The operation of the TT relay depends upon the operation of the ten T relays, and indicates a successful continuity test of the trunk group start leads. A T relay failing to operate prevents the TT relay from operating which in turn blocks the call and causes the timing circuit to function. Without this checking feature a trunk might have an open start lead and not be detected until a service reaction occurred.

All controller circuit T relays not required release. OS 404

The G relay in operating individualizes the ten ST leads of the trunk group. However, several start leads may be grounded due to simultaneous calls in the trunk group and, thereby hold several T relays operated. If the call is not on trunk No. 0, the T-0 relay will release at this time even though it was previously locked.

The lowest numbered operated T-relay locks around the contacts of the TE relay.

The above statement does not apply if T-0 is the lowest relay operated, because it had previously locked and would not have released when the G relay operated.

A sender link primary select magnet PS- in each primary switch operates. OS 405

Some trunk groups are divided over two primary switches. Others are complete on one switch. At this time, the hold magnet of a trunk group to be operated has not been determined. The circuit has been designed not to differentiate between groups requring one or two select magnets, but to operate all three corresponding select magnets in parallel. Then, regardless of what primary hold magnet is operated, the correct crosspoints will be closed. The number of the three primary select magnets that operate is the same as the number of the lowest numbered operated T relay, which corresponds to the number of the trunk having preference.

Controller circuit TE relay operates and locks.

The operating ground for the TE relay is the ground on the start lead of the lowest numbered trunk of the group originating the call. This is another check to see if the call is still waiting to be served before tying up too much equipment.

An additional locking path is closed for the operated T relay. OS 405

The locking of the T relay has now been placed under control of the R relay of the controller circuit. This locks in the preference for the trunk, and whether or not this trunk is disconnected, the call will continue to progress.

SENDER SUBGROUP SELECTION OS 406-407

Regular sender subgroup test is completed with the operation of one or more SG relays. After these relays have operated, the circuit proceeds to select one subgroup from those available. A sender link frame has a preference for one sender subgroup as determined by the cross-connection between the RP and SG punchings of the controller circuit. However, should the preferred sender subgroup be unavailable, there is a chain circuit arrangement through the SG relay contacts which permits the selection of the next sender subgroup in preference. When the SG relays have operated the following occurs:

Sender subgroup connector circuit LL relay operates and locks. OS 406

This path is traced from battery at the M resistance, through the BSG relay normal contacts, RA and R relay normal contacts, TS relay operated contacts, SD relay normal contacts, RP punching, to an SG punching, operated contacts of the preferred SG relay or operated contacts of the next higher numbered operated SG relay, to an LL lead numbered to correspond to the number of the operated SG relay, operated contacts of either the SC-1 or the SC-2 relay, to the winding of the LL relay to ground. There are six LL relays, on a terminating sender link frame. Three of these LL relays are used in conjunction with the first three sender subgroups on the frame and the other three LL relays are associated with the second three sender subgroups. They are provided to establish a lockout between sender link frames since a subgroup of senders may appear on more than one frame. The LL relay of the sender subgroup nearest the ground end of the chain that locks its associated SG relay, and operates the SS relay of the controller circuit is the one in preference.

As described, each terminating sender subgroup may appear at twelve or twenty terminating sender link frames, depending upon whether or not the sender subgroup is a combination group. For each such appearance of a sender subgroup there is an LL relay. These relays are arranged in a chain circuit. Figures A, B and C represent three different terminating sender link frames in the chain circuit. They are not necessarily of the same numerical designation, as a sender subgroup may appear as a different numbered group on different link frames.

It is possible for more than one sender link frame to operate their SG relay associated with the same subgroup of senders, thereby simultaneously operating two or more LL relays in the chain. The operated LL relay nearest the ground end of the chain that locks its associated SG relay and operates the SS relay of the controller circuit is the one in preference. The locking of the SG relay and operation of the SS relay prevents any other SG relay of that controller circuit from operating, thereby preventing the link frame in the preferred position from changing its sender subgroup preference.

The other sender link frames, with their LL relays operated and their SS relays normal, wait until their preference is changed. That can occur in two ways. The first would be for a lower numbered SG relay to operate, due to its associated sender subgroup being returned to service, or the second, when the sender link frame in the preferred position removes the sender subgroup from service, by operating its SGE relay, the SG relays on the other link frames release. If a higher numbered SG relay is operated on these frames, they change their preference to that subgroup and attempt to establish preference.

However, if the preference on the other link frames can not be changed in the second manner, these frames remain with all SG and LL relays normal until some sender subgroup is released. Then they attempt to establish their preference in the subgroup available. If no sender subgroups become available, the link controller circuit times out.

The sender subgroup is wired in a chain circuit with the LL relays of the other terminating sender link frames on which the sender subgroup appears. The LL relays forming such a chain are not necessarily of the same numerical designation, because the subgroup of senders may appear as a different numbered subgroup on other frames. More than one LL relay in a chain may operate simultaneously. However, the one electrically nearest the ground end of the chain circuit used for locking the SG relay will have preference. It should be noted at this time that if the ASG and BSG relays should both operate, due to a trouble, battery would not be connected to the RP punching and sender subgroup selection could not be made. The advance of the circuit under this condition will be considered later.

The operating circuit of succeeding LL relays is opened. OS 407.

Controller circuit SS relay operates and locks and the SG relay locks in parallel.

Additional ground is provided to lock the TC relay and ground the PA lead, in parallel. OS 404.

> This ground is provided in the event that the link used on this call is the last idle link of the trunk group. If such were the case its use would remove ground from the PA lead and interfere with this call, by releasing the TC relay.

Sender subgroup connector circuit C-relay operates. (2 SG relays normal and one operated) OS 408

> There are six C relays on each sender link frame, designated zero to five, one for each sender subgroup. The C relay to operate is either the 0, 1 or 2, or the 3, 4 or 5. The circuit for operating the C relay is so wired that it is necessary to have all but one SG relay normal. The reason for this arrangement is to prevent the operation of the C relay, until the selected sender subgroup is locked in and the SS relay is operated, in order to prevent operating and releasing C relays, due to this sender link frame changing its preferred group.
>
> The operation of the sender SS relay prevents any change of preference for operating an LL relay by opening the operating paths of the SG relays, and releasing all except the one locked in. When the SS relay is operated and the preferred sender subgroup locked in, this same sender subgroup is still available to other frames since the SGE relay has not been operated yet, but is unusable due to the LL relay chain. Any sender link frame that picked this sender subgroup under this condition, therefore, would fail to operate its SS relay and would wait until the sender subgroup became usable via its LL chain, or change its preference when the sender subgroup is later removed from service.

SENDER LINK FRAME INDICATION

During the progress of a call it is necessary for the incoming link frame to identify itself by number to the sender circuit, which in turn transmits this information to the terminating marker. The number of a regular sender link frame and the incoming link frame correspond when involved in a call. This will not always be the case when an auxiliary sender link frame is working with an incoming link frame. This is because more than one incoming link frame is served by the auxiliary frame. Therefore, when an auxiliary frame is serving a call it is the combination of operated C- and TG-relays that determine what F leads will be grounded.

Since there are a possible 20 incoming ~~sender~~ link frames in one office, ten F leads designated zero to nine are provided for indicating the units digit of the frame number, one F-00 lead for indicating the first group of ten frames and an F-10 lead for indicating the second group of ten frames. Therefore, two F leads are used at each sender link frame, one of the F-0 to F-9 with the F-00 or F-10 lead.

The F lead used in the group F-0 to F-9 on any sender link frame is multipled to each of the three C relays on that frame. The F-00 lead is multipled to all C relays on the first ten sender link frames (0 to 9) or that portion of the first ten frames equipped. The F-10 lead is multipled to all C relays on the second ten frames (10 to 19) or that portion of the second ten frames equipped.

The grounding of an F lead and the F-00 or F-10 by the C relay in operating sends the frame indication to the sender when connected. On even numbered sender link frames the C relay also grounds the EF lead to their associated senders.

MULTI-OFFICE OPERATION CALLED OFFICE IDENTIFICATION

In some installations a common group of incoming frames may be used to serve two physical crossbar offices each containing its own 10,000 number series. When that condition exists, one method used to determine the called office requires the originating equipment to select a group of trunks common to both offices and call for either a regular number of revertive pulses in incoming group selection or the regular number plus 5 additional pulses. This was previously discussed in the originating sender test. The other method is for the originating office to have separate trunk groups to each of these offices in turn requiring that the incoming individual trunk group equipment pass to the sender the information regarding which office is being called. Each TG relay in addition to serving only one kind of trunk must then serve only trunks to one of the terminating offices. The "YB" wiring is then provided at the ~~TB~~TG and C relays to ground either the OA or OB leads either one indicating a particular office.

SENDER SELECTION

The operation of the C relay connects the controller circuit to the selected subgroup of senders. The sender is selected by means of a preference chain circuit and a set of preference leads connected to the ten T relays. The preference lead grounded corresponds in number to the incoming trunk being served.

Sender subgroup circuit GAT relay operates.

> Cross-connections are made between the "A" or "B" punchings at the GAT or GBT relays to the P punchings located at the sender subgroup circuit SB relays depending upon how many senders of each of the two kinds there are in the subgroup. If there were six of the first kind of senders and four of the second, the P0 to P5 would be cross-connected to A0 to A9 and the P6 to P9 would be cross-connected to the B0 to B9 punchings, making it necessary to strap certain adjacent punchings on the GAT and GBT relays.

Sender subgroup circuit S-relay operates and locks. OS 409

There are ten S relays 0 to 9 in a sender subgroup. If the preferred sender is busy, the next available idle sender in the preference chain is selected depending on which of the sender subgroup circuit SB relays are operated. There is an S relay and an SB relay for each sender in the subgroup.

Sender subgroup circuit SGE relay operates.

Ground is removed from the RT and TT leads.

The sender subgroup is now made unavailable to other sender link and controller circuits.

Terminating sender circuit SC-1 relay and sender link secondary select magnet SS- operate in parallel. OS 410

The secondary select magnet that operates corresponds in number to the S relay that is operated, and the C relay directs the circuit to the proper subgroup of senders.

The operate path of the SC-1 relay checks for battery through the CO resistance lamp, this being of great importance at a later stage in the call.

FALSE GROUND TEST OS ~~410~~ 412

The GS, TR, RL and SL leads are common to the ten senders of the subgroup and are connected to an individual sender by the operation of the SC-1 relay of that sender. These leads are also multipled to the corresponding C relays of other link frames served by the same subgroup of senders. When the C relay operates, these leads are connected through the normal contacts of the controller circuit HM relay where they are bunched and tested by the controller circuit FG relay for false grounds. The FG relay in operating prevents the controller circuit from advancing, thereby causing the timing circuit to function.

SENDER SEIZURE AND REGISTRATION OF FRAME INDICATION

The operation of the terminating sender SC-1 relay and the sender link secondary select magnet results in two simultaneous circuit advances, namely, sender seizure, and the operation of the sender link hold magnets.

Seizure of terminating sender is shown on OS 411.

At the same time, one terminating sender circuit select magnet operates. From ground on one of the F0 to F9 leads. OS 410

There are ten select magnets, numbered 0 to 9. The one to operate corresponds in number to one of the F0 to F9 leads that is grounded by the sender link C relay. Battery for the select magnets is supplied through the winding of the XSM relay which is marginal and will not operate except when two select magnets are grounded at the same time. On this call it is assumed that only one select magnet is grounded and, therefore, the XSM relay does not operate. An explanation of the function of this relay is given later under miscellaneous conditions.

If the F-00 relay is operated, the number of the select magnet operated indicates the number of the incoming link frame involved on this call. If the F-10 relay is operated, the frame number of 10 higher than the number of the select magnet.

OPERATION OF SENDER LINK HOLD MAGNETS

At this time there are three primary select magnets and one secondary select magnet operated on the sender link frame. One of the primary select magnets is directly associated with the selected trunk. The secondary select magnet operated is associated with the selected sender. In order to connect the incoming trunk with the sender circuit it is only necessary to operate the hold magnets of the link that has access to the trunk group and sender subgroup. The operating circuit of the controller circuit HM relay is traced through the normal contacts of the false ground relay FG.

Controller circuit HM relay operates.

Controller circuit FG relay is disconnected from the RL, GS, TR and SL leads.

A sender link primary PH- and a secondary SH- hold magnet operate in parallel.
OS 410

The ground from the operated contact of the SS relay is extended through the HM relay contacts around the winding of the TST relay, through an operated SG relay to a TH lead. The connection of the ground through an operated SG relay to a TH lead determines that one end of the link must have its secondary hold magnet on the switch that is associated with the selected subgroup of senders. The TH leads are multipled at ten TG relays. An operated TG relay connects the grounded TH lead to the sleeve of the link that has its secondary hold magnet on the switch associated with the selected sender subgroup and its primary hold magnet on the switch to which the preferred trunk is connected. From the sleeve of the link, the circuit is traced through the normal contacts of the LR relay to the secondary and primary hold magnets. The crosspoints are closed, connecting the T, R, CO, FC and D leads of the incoming trunk and the S lead of the sender link to corresponding leads to the sender.

DOUBLE CONNECTION TEST OS 410

A test is made on the sleeve of the link to determine whether or not the crosspoints have been closed on a busy link or grounded sleeve. The ground that operated the hold magnet is directed around the winding of the controller circuit TST relay by the normal contacts of the controller circuit SL relay to the sender sleeve crosspoints. The ground is then extended over the sender sleeve to the sender SC-1 relay, back on the common SL lead to the winding of the controller circuit SL relay.

Controller circuit SL relay operates. (SH-hold magnet)

The short circuit is removed from the controller circuit TST relay.

The ground holding the SL relay operated now comes through the winding of the controller circuit TST relay providing the sender sleeve is not falsely grounded. Should the sleeve be grounded the TST relay is short circuited and will not operate thereby blocking the progress of the call and causing the timing circuit to function. For this call it is assumed that no double connection is encountered and that the circuit continues as follows:

SENDER ADVANCE OS 411

Before dismissing the sender link and controller circuit it is necessary to lock in the selected link under control of the sender and to advance the sender to the point at which its L relay is connected in series with the STP relay of the originating sender as shown on OS 416.

The ON-1 relay operates OS 411.

Sender subgroup circuit SB relay operates.

Over the SB lead. OS 414

Terminating sender circuit ON-2 relay operates and locks. OS 411

The ON-2 relay operates over the BS lead, provided that the RA-1 relay is operated, (indicating that the register advance relays are set in condition for the start of the call) the XSM relay is normal (indicating only one select magnet operated, which is assumed condition) and either OA or OB relay and the F-00 or F-10 relay are normal. From the above it will be seen that this operating circuit checks that the register advance relays have functioned and that only one frame indication has been received.

Terminating sender circuit SPL relay operates, if the FC lead is grounded. OS 418

If an incoming trunk requires the use of a special terminating marker, it connects ground to its FC lead. The contact of the ON-1 relay is used as the final closure of this lead to prevent wear on the sender link crosspoint contacts.

Ground is connected to the SPL lead to the terminating marker connector.

The terminating sender circuit connects battery to the T lead and ground to the R lead to the originating sender. OS ~~416~~ 417-1

This battery and ground are connected in parallel with the battery and ground from the incoming trunk which is holding the STP relay in the originating sender. This is done at this time in order to prevent any interruption of battery and ground, due to incoming trunk functions described later, which might cause the registration of a false pulse in the originating sender. The terminating sender L relay may or may not operate at this time. On short trunk loops the L relay does operate when the ON-1 relay operates, in turn operating the L1 and L2 relays. The terminating sender at this time advances in two ways. The first is to dismiss the sender link and controller circuit, the second is to prepare for selections. The advance to dismiss the sender link is considered at this time.

Terminating sender circuit SC-2 relay releases. OS 416

The F leads are disconnected from the select magnets.

The operated select magnet does not release, as it and the operated SM relay are locked until both the HM and L-2 relays operate.

Terminating sender circuit F hold magnet operates and locks.

When the RA-1 relay previously operated it connected the winding of the F hold magnet to both windings of the HM relay. These windings are differentially connected and so proportioned that the relay will not operate or hold with the same current in the both windings; nor will it operate with the combined current through the hold magnet and the secondary winding in parallel, passing through the primary winding. The hold magnet does operate, however, under the latter condition, which occurs as soon as the ON-2 relay operates and connects ground to the primary winding of the HM relay.

The crosspoint contacts are closed at the level of the operated select magnet.

The closure of the crosspoint contacts connects ground to a combination of numbered F leads to the terminating marker connector.

Terminating sender circuit HM relay operates.

The F hold magnet locks to the ON-1 relay and extends its locking ground to the primary winding of the HM relay, thereby short-circuiting that winding and allowing the HM relay to operate on its secondary winding.

Controller circuit RL relay operates and locks, the TST relay is short-circuited and releases, the SL relay and PH hold magnet hold and the SH hold magnet locks, in parallel.

The ON-2 relay in operating connects ground to the S, SL and RL leads to the sender link frame. Ground connected to the RL lead operates the controller circuit R relay. At the sender link the S lead is connected through the link crosspoints to the TH lead causing the TST relay to be short-circuited and released. At the link crosspoints, the S lead ground locks and SH hold magnet and the PH hold magnet holds. Ground being connected to the SL lead, holds the SL relay. All the above described network is in a parallel circuit being operated from the off-normal ground lead in the sender, supplied from the operated contacts of the ON-2 relay through the released contacts of the RL and TRL relays.

RELEASE OF THE SENDER LINK CONTROLLER CIRCUIT

With the operation of the controller circuit R relay, all parts of the sender link controller circuit start to release and the incoming trunk is thereby advanced so as to cut through the originating sender to the terminating sender. However, the operated PH and SH magnets and the sender subgroup SB relay will not be released at this time as they are held operated under control of the terminating sender.

Sender subgroup circuit SGE relay releases. OS 409

At this time the sender subgroup used for this call is made available for use on other sender link frames.

Incoming trunk circuit T relay operates. OS 416

When the terminating sender SC-1 relay releases it closes ground through its own normal contact, through normal contacts of TC-2 relay, operated contacts of the RV-4 and ON-1 relays, to the CO lead, through the closed crosspoints on the secondary and primary switches of the sender link frame to the incoming trunk operating the T relay. By this time it is certain that the sender link and controller circuit has made all its checks and is definitely going to use this particular sender, also that the sender link switches have had time to close through the T and R leads from the incoming trunk to the terminating sender and that the ON-1 relay has operated and closed through the T and R leads to battery and ground, respectively.

The incoming trunk T relay in operating removes the battery and ground from the incoming trunk to the originating sender, and leaves the terminating sender battery and ground connected. This overlap of both batteries and grounds is to insure that the originating sender STP relay will not be falsely released and thereby register a false pulse.

Incoming trunk A relay releases and the controller circuit T relay releases.

The incoming trunk A relay in releasing removes ground from the ST lead to the terminating sender link and controller circuit, thereby releasing the controller circuit T relay that was locked to this ST lead ground.

RL relay operates and locks. OS 412

The RL relay checks that there are no T relays held falsely operated that might interfere with the next call. The operating path of the RL relay is traced through a double chain circuit of all the T relays normal.

The RL relay locks to the operated RS, TS, TC and HC relays.

Start circuit CA relay releases. OS 402

The CA relay releases at this time provided that there are no other GA relays operated, which would be the case in the event of no simultaneous calls. If any other GA relays are operated the CA relay remains locked and keeps the GTA relay locked until all trunk groups having GA relays operated are cared for. When that occurs the following happens:

Controller circuit RA relay releases.

At this time the sender link controller circuit is released and available for another call, and the call just completed by this controller circuit is connected in such a manner that the originating sender is connected to the terminating sender by the incoming trunk and the operated PH and SH hold magnets of the sender link.

CHAPTER 6

SECTION 3

MISCELLANEOUS INFORMATION AND FEATURES

Terminating Sender Link and Controller Circuit SD-25459-01

MARCH 1954

TRAFFIC LOCK OUT SC 401 OS 401-402

More than one incoming trunk group may originate calls simultaneously. The GA relay associated with each trunk group operates and locks around the contacts of the GTA relay. When the H and HC relays of the controller connector circuit operate the lowest numbered operated GA relay is locked to the HC relay and the GTA relay is operated. The GTA relay, known as a gate relay, opens the operating circuit of all GA relays. However, those previously operated and locked to their respective ST leads remain operated as they are locked around the contacts of the GTA relay. The GA relay that is locked to the HC relay (the lowest numbered operated relay) is served first.

The GA relay of the trunk group being served, releases when the DA relay of the controller circuit is operated by the RA relay of the controller circuit, at the termination of the call. The CA and GTA relays do not release at that time but are held operated by the remaining operated GA relays. The trunk group corresponding to the next lowest numbered operated GA relay is then served. All waiting trunk groups are served in this manner and no other trunk groups can operate their associated GA relay until the CA and GTA relays release. This occurs when there are no GA relays operated waiting to be served. When the last group of trunks is served the CA and GTA relays release and the release of the GTA relay restores the operating paths of all the GA relays. This arrangement allows one waiting call to be served in each trunk group before another call can be served in any of the groups just served.

RESERVE SENDER TEST SC 401 OS 404, 406 and 409

As stated, the reserve test is for a sender subgroup which has one idle sender and an idle link from the trunk group originating the call. When relay TS operated it signified the end of trunk selection and released the SR relay which in turn operated the RS relay. This starts the reserve test, if required. The SR relay is slow to release to allow sufficient time for the completion of regular sender test and for the condition of some sender subgroup to change to two senders available before proceeding with the reserve test.

When the RS relay operates, the GTA and GTB leads are transferred from the TT and TB leads to the RT and RB leads. The path of the GTA or GTB leads is the same as for the regular sender subgroup test, that is they originate at the SG-0 to 2 relays. The RT and RB leads from operated contacts of the RS relay are wired through the contacts of the ASG and BSG relays, respectively. From this point, as for regular test, they are wired through the contacts of the HC relay to the normal contacts of the sender subgroup SGE relay. The wiring arrangement of the RT and RB leads and the SGE relay is the same except that the upper contacts of the SGE relay are used.

The RT and RB leads from the SGE relay are connected to ground through the normal contacts of the AGB and BGB relays respectively. From this arrangement it can be seen that the AGB or BGB relays when normal indicate at least one idle sender, as these relays are operated when all senders of the subgroup are busy. Therefore, this reserve test is for an idle link from the calling trunk group to an available sender subgroup (SGE normal) having at least one sender idle.

When the RS relay operates, then one or more of the SG-0 to 2 relays will operate, provided that the trunk group originating the call has an idle link to one or more sender subgroups having one idle sender. The circuit will continue from this point by an LL relay operating from an SG relay that has operated on the reserve test.

EMERGENCY OPERATION OS 413, 402

Each two sender link frames are arranged to work as mates, so that when trouble develops in the controller circuit of either frame, service will be furnished to both frames by the remaining controller circuit, which acts as a common controller circuit.

In this case the common controller circuit serves calls alternately on the two frames.

When an odd number of terminating sender link frames are installed in an office, an emergency or mate controller circuit is supplied for the odd frame. The relays of this controller circuit are located on the miscellaneous relay bay.

Approximately 5 to 12 seconds are allowed in which to serve a call. If it is not served within that time, the timing circuit functions to free the call involved from the home controller circuit and place subsequent calls in the mate controller circuit. When the CA relay operates or when the DA relay operates and the FA relay releases, ground is connected to the IA interrupter causing the following:

Start circuit TA relay operates and locks.

When the B contact of the IA interrupter closes.

Start circuit TA-1 relay operates and locks.

When the F contact of the IA interrupter closes. An additional locking circuit is supplied for the TA relay and an additional ground is connected to the IA interrupter, in parallel with the locking circuit of the TA-1 relay.

An additional locking circuit is supplied for the GTA relay.

An additional locking circuit is supplied for the operated GA relay being served.

An additional holding circuit is supplied for the group circuit G relay.

Start circuit CA and FA relays release in parallel.

Controller connector circuit H and HC relays release.

The release of these two relays causes the controller circuit to disconnect, as described in a regular call. However, the start circuit GA and GTA relays and the group circuit G relay are held operated by the TA-1 relay.

At the start of every call the start circuit GA and GB relays are operated. The GB relay is released by the operation of the group circuit G relay as the call is served. If any calls entered the start circuit simultaneously with the one involved on this failure, their associated GB relays are still operated. Any other calls that originated after the operation of the GTA relay can not operate their associated GA relay. However, the GB relays associated with such groups can be operated, as the GTB relay is normal. Therefore, at this time there is a GB relay operated for each trunk group that is originating a call, except the GB relay of the group, involved in the failure.

When the CA relay and the DA relay (if operated) release, and if the FA relay of the mate start circuit is normal (indicating that the mate controller circuit is idle) the CB relay operates to ground through the operated contacts of the GB relays. The operation of the CB relay causes the "B" start circuit to function and connect to the mate controller circuit to serve the waiting calls. If the CB relay can not operate at this time, due to the mate controller circuit being busy, it is operated.

Start circuit TA-2 relay operates and locks.

When the B contact of the IA interrupter closes.

Ground is disconnected from the IA interrupter.

Start circuit AL lamp is lighted and ground is connected to the AL lead.

Ground is connected to the A lead.

The ground on the A lead causes an audible alarm to function and the aisle pilot lamp to be lighted.

Start circuit CB relay operates.

If the CB relay has not as yet operated due to the mate controller circuit being busy on a call, the operation of the TA-2 relay will operate it independently of the condition of the mate controller circuit.

The "A" start circuit is now out of service and all subsequent calls are cared for by the "B" start circuit and the mate controller circuit. The CB relay is a slow operating relay and is now working with the CA relay of the mate frame, which is a fast operating relay.

The CB relay can operate while the mate frame is busy on a call. This permits the "B" start circuit to advance to the point of operating its FB relay. This removes the slow operate feature of the CB relay at this time, insuring that the home frame will receive preference when the mate frame has completed its call.

The operating circuit of the FA relay of the mate start circuit is traced through the normal contacts of the FB relay of the home start circuit. The operating circuit of the FB relay of the home start circuit is traced through the normal contacts of the FA relay of the mate start circuit. This arrangement places the FB and FA relays in a chain circuit so that one can not operate unless the other is normal.

The circuit arrangement of the FB and FA relays when combined with the operating path of the CB relay causes the one controller circuit to be alternated between both frames. However, in the event of simultaneous calls the mate frame will be the first to seize the controller circuit, because its CA relay can operate faster than the CB relay of the home start circuit.

Start circuit TA and TA-1 relays release and ground is disconnected from the IA interrupter in parallel.

Start circuit GTA and GA relays and group circuit G relay release.

The reason for holding the above three relays operated until this time is to prevent, if possible, the operation of the GB relay associated with this group until after all other waiting groups have been cared for. Therefore, in most cases the incoming trunk group involved on a time out will not be served until all other waiting groups have been served.

If both the BSG and ASG relays of the controller circuit were operated, due to a trouble, a sender subgroup could not be selected and the frame would be cleared.

If the PA lead ground ceases to be available to the selected sender subgroup, after the GA relay is locked to the HC relay, this frame will time out.

If, when the TA-2 relay operates, the mate controller circuit is out of service, due to its MB relay being operated, the TA-2 relay will receive no locking circuit and immediately releases. This restores the "A" start circuit to service.

FRAME TROUBLE OS 413

If the trouble which caused the time alarm condition was in the controller circuit, no further time out will occur on the home frame after the initial time out has taken place. However, if the trouble was in the frame equipment, or if for any reason a call is blocked after starting through the "B" start circuit, the 1B interrupter, TB, TB-1, and TB-2 relays function, in the same manner as that described for the "A" start circuit. This removes the "B" start circuit from service. The operation of the TB-1 relay opens the locking circuit of the TA-2 relay releasing it, thereby returning the "A" start circuit to service.

Each time a call is blocked, a transfer is made from one side of the start circuit to the other. Each time such a transfer is made, the trunk group involved on the trouble is locked out until other waiting groups are served.

The alarm and aisle pilot lamps do not restore after any time out, until the TR key is operated. The operation of the key releases the TA-2 or TB-2 relay thereby restoring the frame to service on its "A" start circuit.

FALSE GROUND ON COMMON LEADS TO THE SENDER SUBGROUP OR THE FAILURE OF SENDER LINK CROSSPOINTS TO CLOSE MIN. 1.06 SEC. TO MAX. 2.12 SEC. SC 402 OS 412, 410

If there is a false ground on leads RL, GS, TR or SL of the sender subgroup, the FG relay is operated. The operation of the FG relay prevents the operation of the HM relay and, therefore, no crosspoints are closed.

If there is no false ground on the common leads of the sender subgroup, the HM relay operates resulting in the operation of the PH and SH magnets. However, if due to a trouble, the crosspoints failed to close the controller circuit would be unable to operate its SL relay.

In either of the two cases the sender link circuit proceeds as in a regular call up to the operation of the HM relay or the closure of the secondary crosspoints. These two troubles are automatically cleared in the same manner except for a few minor variations.

The sender link and controller circuit at this time has advanced to the point where the secondary select magnet is operated, the HM relay or the link holds magnets may or may not be operated. The terminating sender is seized, as in a regular call and its SC-1 and SC-2 relays are operated. If the trouble was due to a failure of the link crosspoints to close, in addition the following sender relays are operated: F-00 or F-10, OA or OB, RV-3, RV-4, RV-5, SM, RA-1 and the EF relay if required. A select magnet is also operated.

If the trouble is due to a grounded common lead, the sender link controller circuit and terminating sender circuit are advanced as before, the sender SC-1 and SC-2 relays being operated. In this case, additional sender relays may be operated depending upon how far the call has progressed.

When the sender link controller circuit SS relay operates the ST interrupter circuit is closed.

Sender subgroup connector circuit AMB and BMB relay operates. OS 415

> The relay to operate is determined by the type of sender used. Both relays are operated if a combination sender subgroup is involved. The operation of the AMB or BMB relay, or both, prevents the associated sender subgroup from being reused on this frame until the present call is disposed of.

The PA lead of every link having access to the sender subgroup is opened.

> The PA leads are opened because the sender subgroup involved on the failure is being held out of service to this frame. However, this does not affect the common PA lead of the trunk group or controller circuit as at this time it is grounded by the operated contacts of the SS relay.

Start circuit AL relay operates and locks.

Start circuit AL lamp is lighted.

Ground is connected to the A lead to the floor alarm board.

This ground actuates the minor alarm. The AL relay remains operated, the A lamp lighted and the minor alarm ringing until such time as the TR key is operated.

The ST interrupter circuit is opened. OS 415

Controller circuit Y relay releases.

Sender subgroup connector circuit C relay releases.

Controller circuit FG relay, if operated, releases.

Sender subgroup circuit GAT or GBT relay releases.

Terminating sender F-00 or F-10, RV-3, RV-4, RV-5, RA-1, EF and SM relays and the operated select magnet release.

If the failure was due to no link crosspoint closure, the release of the sender subgroup connector circuit C relay releases the above mentioned terminating sender equipment, as at this time all sender equipment except the SC-1 and SC-2 relays is operated or locked to ground on the F leads. If the failure was due to a falsely grounded common lead, and the selected sender was idle, the same sender releases occur.

However, if the selected sender was busy and the SL or GS lead grounded (thereby causing the FG relay of the controller circuit to operate) in all probability the sender circuit ON-1 and ON-2 relays are operated. The sender might be pulsing and registering selections and the F lead grounds might cause two select magnets to operate. If that occurred the call attached to the sender (other than this call) would receive a trouble release from the terminating marker, as two crosspoints closed for the same selection causes a double marker failure.

If the selected sender were busy and the RL or TR leads grounded it indicates that the sender is in the process of disconnection and the F lead grounds of this call would cause no material damage to the call just completed.

However, in any case the call involved on this failure is not completely free of the sender as yet. It is released from the sender.

Sender subgroup circuit S relay and the sender link secondary select magnet release. OS 409

Terminating sender circuit SC-1 and SC-2 relays release. OS 403

At this time the call is free from the selected sender.

Sender subgroup circuit SGE relay releases. OS 409

> The sender subgroup is now available for use by other sender link and controller circuits. It can not be selected by the link frame on which the failure occurs as the associated AMB or BMB or both relays are operated.

Controller circuit SG relays operate. OS 406

> Only two SG relays can operate upon the release of the SS relay provided that there is an idle link available from the calling trunk group to the available sender subgroups. The third SG relay (associated with the previously used subgroup) can not operate as the AMB or BMB relays of that subgroup of senders are operated. If no sender subgroups are available, the call proceeds. For this call it is assumed that the links and remaining sender subgroups are available.

Controller circuit CP relay operates and locks.

Sender subgroup connector circuit LL relay operates and locks. OS 406

> The LL relay to operate depends upon the connection of the RP punching and the SG relays operated. The call proceeds from this point as in a regular call. On the second trial a different subgroup of senders is used, rather than to risk a possible repeated failure in the sender subgroup. If the call succeeds on the second attempt the operation of the controller circuit RL relay releases the CP and SD relays and the operation of the controller circuit RA relay releases the AMB or BMB relays. If on the second trial, no sender subgroups are available or if for any reason the call is not successfully completed, the IA or IB interrupter functions and causes the frame to use its mate controller circuit, as described under emergency operation.

DOUBLE CONNECTIONS MIN. 1.06 SEC. TO MAX. 2.12 SEC. SC 402 OS 415

When the crosspoints of the sender link secondary switch close, if the S lead is falsely grounded the SL relay operates as on a regular call. The TST relay does not operate as there is ground on both sides of its winding.

If the S lead is falsely grounded the selector sender advances to the point prior to the operation of its ON-1 relay. If the sender ON-1 and ON-2 relays were operated prior to the operation of the sender link hold magnets, the false ground test would be effective. Therefore, for this condition the sender is in position prior to the operation of the two above mentioned relays.

The ST interrupter is closed by the operation of the controller circuit SS relay. The interrupter operates and releases the W and Z relays and they in turn perform the same functions. With the Y relay operated and when both the W and Z relays are normal (after the second break of the interrupter contact) the operations on SC 402 occur:

All operated PH and SH hold magnets, associated with the secondary switch corresponding to the selected sender subgroup, release. OS 410

Any calls that are at present connected on this secondary switch are disconnected. The calls so disconnected will cause stuck senders at the originating office. However, the probability of any other hold magnets being operated, other than those involved on this call, is rather small.

Sender subgroup circuit SB relay operates. OS 411

The controller circuit SRL relay in operating connects ground to the GS lead to the selected sender operating the ON-1 relay. The sender ON-1 relay performs the same functions as for a regular call. The sender advances and registers the frame indication after which the following sender relays and magnets are operated: SC-1, F-00 or F-10, RV-3, RV-4, RV-5, SM, RA-1, ON-1, ON-2, HM, EF (if frame number is even), one select magnet and the F hold magnet.

Controller circuit SL relay operates. OS 410

The terminating sender circuit ON-1 relay ground is extended to the controller circuit SL lead, thereby operating the controller circuit SL relay.

Terminating sender circuit RL relay operates. OS 412

The controller circuit SRL relay in operating connects ground to the TR lead to the sender operating the RL relay. However, the operation of the RL relay has no effect, except to open the ST lead to the terminating marker connector circuit, as the ON-1 relay is held operated until ground is removed from the GS lead.

Controller circuit SG relays operate. OS 406

The AMB and BMB relay of the sender subgroup involved on the failure is still operated. Therefore, the SG relays to operate are associated with the two remaining sender subgroups, provided that there is an idle link from the trunk group originating the call to the available sender suggroup.

Terminating sender circuit ON-1 relay releases.

The controller circuit SRL relay in releasing disconnects ground from the GS lead, thereby releasing the terminating sender ON-1 relay. However, if the sender SC-1 relay is released, prior to the operation of the controller circuit SRL relay, it opens the GS lead causing the release of the sender ON-1 relay.

The release of the ON-1 relay, causes the sender circuit to return to normal by releasing the F-00 or F-10, RV-3, RV-4, RV-5, SM, RA-1, HM, ON-2, SPL, (if operated) RL and EF (if operated) relays and the operated select and F hold magnets. The release of the sender circuit RL relay, causes the following:

Sender subgroup circuit SB relay releases. OS 411

At this time the sender involved on the failure is normal and available for reseizure by another link frame.

Sender subgroup circuit SGE relay releases. OS 409

At this time the sender subgroup involved is available for service at the other sender link frames. However, it is not available for use on this frame as the AMB and BMB relay is still operated.

Controller circuit CP relay operates and locks.

From this point the call proceeds as described under false ground test. If a second failure occurs (double connection, failure to close crosspoints, or false ground on common leads) the sender link frame is cleared as described under emergency operation.

This occurs because the SD and CP relays remain locked until the RL relay operates. A failure on the second trial, with these two relays operated, prevents the release of the LR and LL relays. Failure to release the LL relay prevents the further release of the control circuit and the IA or IB interrupter therefore functions.

FAILURE OF THE TERMINATING SENDER TO RETURN A RELEASE SIGNAL SC 402 OS 415

If due to a trouble, the terminating sender circuit ON-2 relay failed to operate, ground is not connected to the RL lead to the sender link and controller circuit. Any of the following trouble conditions prevents the operation of the sender ON-2 relay.

If the controller circuit fails to ground either the F-00 or F-10 lead, the sender RV-3, RV-4, and RV-5 relays can not operate. Failure of any one of these relays to operate opens the operating circuit of the ON-1 relay. This prevents the operation of the sender subgroup circuit SB relay, thereby preventing the subsequent operation of the sender ON-2 relay.

If the controller circuit fails to ground one of the leads F-0 to F-9 to operate a select magnet, the SM and RA-1 relays can not operate. Failure of either of these two relays to operate, opens the operating circuit of the ON-2 relay.

If the controller circuit grounds both the F-00 and F-10 leads, resulting in the operation of both the F-00 and F-10 relays the ON-2 relay is prevented from operating.

If the controller circuit causes the operation of two or more select magnets, the XSM relay operates, thereby preventing the ON-2 relay from operating.

If the controller circuit grounds both the OA and OB leads the operation of both the OA and OB relays prevents the ON-2 from operating.

Any of the above cases or any other trouble condition that prevents the grounding of the RL lead affects the release of the controller circuit. The W and Z relays of the controller circuit function under control of the ST interrupter, as described for a double connection. When the interrupter contact breaks for the second time the following occurs:

The operated link PH and SH hold magnets and the controller circuit SL relay in parallel, and the TST relay in series, release. OS 410

> The SL relay operated over its normal operating circuit when the terminating sender SC-1 relay operated. This resulted in the TST and DC relays operating.

Controller circuit SRL relay operates and locks. OS 415

Controller circuit SD relay operates and locks.

> From this point the controller circuit advances to make a second trial and the terminating sender is disconnected, as described under "Double Connections." A failure on the second trial causes the IA or IB interrupter to function as described under emergency operation.
>
> However, if the open RL lead was caused by a trouble that did not affect the operation of the sender ON-1 and ON-2 relays, the SL relay, the PH and SH hold magnets would remain operated to ground on the SL lead from the terminating sender. In this case the ST interrupter continues to function and when its F or B contact closes, the following occurs:

Controller circuit W relay operates and locks. OS 415

> When the B contact of the ST interrupter closes.
>
> Controller circuit Z relay is short-circuited.

Controller circuit R relay operates and locks.

> From this point the controller circuit is disconnected as in a regular call.

INCOMING TRUNK CIRCUIT FROM OUTGOING TRUNK TEST FRAME PURPOSE OF CIRCUIT OS 401

This incoming trunk circuit is designed to connect the outgoing trunk test frame to the terminating equipment in a crossbar office, so that the subscriber line test circuit located at the frame may have access to subscriber lines.

The test sender associated with the outgoing trunk test frame is used for setting up the connection through this circuit.

SEIZURE

When it is desired to use this trunk in connection with the subscriber line test circuit of the outgoing trunk test frame, certain keys of the frame are operated resulting in ground being connected to the H lead of this trunk, causing the following:

Incoming trunk circuit H relay operates.

Ground is connected to the FC lead.

The operation of the test keys also result in the test sender of the test frame, receiving a record of the called number from the recording keys.

After this is completed, the sender makes trunk guard test to battery and ground supplied by the A relay of the trunk circuit. The resistance of the trunk guard loop is high enough to prevent the operation of the trunk circuit A relay.

When the test frame sender advances to its incoming brush position the following occurs:

Test frame sender STP relay and the incoming trunk circuit A relay operate in series.

Ground is connected to the ST lead to the terminating sender link and controller circuit.

This causes the sender link and controller circuit to function as in a regular call. When the sender link crosspoints close and the terminating sender ON-1 relay is operated, the terminating sender SPL relay operates to ground on the FC lead. This lead is grounded by the operation of the trunk circuit H relay, because this trunk required the service of a special marker.

The operation of the terminating sender ON-1 relay connects battery and ground to the trunk loop in parallel with the battery and ground of the trunk circuit A relay. When the SC-1 relay of the terminating sender is released ground is connected to the CO lead causing the following:

Incoming trunk circuit T relay operates.

Incoming trunk circuit A relay releases.

The terminating sender now generates and counts pulses as in a regular call. When all the selections have been recorded a reverse battery and ground pulse is sent to advance the test frame sender. After the successful completion of incoming advance the terminating sender removes ground from the CO lead causing the following:

Incoming trunk circuit T relay releases.

Ground is connected to the R lead to the terminating sender link circuit.

The incoming trunk circuit A relay can not reoperate at this time as the terminating sender is maintaining a battery on the T lead. The ground connected to the R lead causes the RV-5 relay of the sender to release and connect ground to the D lead causing the following:

Incoming trunk circuit D relay operates and locks.

Ground is disconnected from the FC lead to the terminating sender link and controller circuit.

Ground is connected to the S lead to the incoming link circuit.

Ground is connected to the D lead to the terminating sender link and controller circuit.

Ground on the D lead operates the terminating sender TC-1 relay as a signal that trunk closure is completed. Under ordinary operation (a regular call) trunk closure is effective when the originating sender or district closes the trunk. In the present instance trunk closure is immediate due to the subscriber line test circuit controlling the connection. Upon receipt of the trunk closure signal the terminating sender summons a special marker to serve the call. The marker during its functions grounds the FC lead causing the following:

Incoming trunk circuit F relay operates.

The RV, RC, TC and HF leads from the incoming link circuit are connected to the windings of the incoming trunk circuit RV, RC, TC and TH relays, respectively.

The S and SL leads to the incoming link circuit are connected together.

Ground is connected to the LC lead to the incoming link circuit.

Ground is connected to the M and the M-1 lead to the incoming link circuit.

Ground is connected to the NH or NHX lead to the incoming link circuit.

The ground for the NH or NHX lead is supplied from the O.G.T. board and controlled by a key. The NH lead when grounded indicates to the terminating marker that the number is within the regular 10,000 series and that terminal hunting is to be cancelled. Ground on the NHX lead indicates that the number is in the coded group, which are numbers above 10,000 and that terminal hunting is to be cancelled. Therefore, this type of trunk is commonly referred to as a no hunt trunk. The marker proceeds to establish the connection on a no hunt basis and connects ground to the RC lead causing the following:

Incoming trunk circuit RC relay operates and locks.

Ground is connected to the RC lead to the incoming link circuit.

The RC relay extends its locking ground to the RC lead. This ground is used to satisfy the marker when it checks that the proper ringing control relay has operated.

Ground is connected to the RP lead to the O.G.T. board.

Ground connected to the RP lead to the O.G.T. board lights an RP lamp, indicating the line connected is cross-connected as an individual line.

When the line connected is a first or intermediate line in a P.B.X. group, the terminating marker connects ground to the HF lead at the same time that ground is connected to the RC lead. This will cause the incoming trunk TH relay to operate and lock. The HG lead to the O.G.T. board is grounded under this condition and causes the HG lamp to light.

On a tip party of a two-party line, the RC and RV relays are operated, grounding the TP lead and lighting the TP lamp.

If the called line is idle, which is the assumed condition, the marker establishes connection to the called line and removes ground from the FC lead causing the following:

Incoming trunk circuit F relay releases.

The RC, RV, HF, TC, and SL leads to the incoming link circuit are opened.

Ground is disconnected from the LC and M leads to the incoming link circuit.

Ground is disconnected from the HN or NHX lead to the incoming link circuit.

Ground is connected to the S lead to the incoming link circuit.

This ground locks the hold magnets in the established connection. It is necessary to connect this ground through ten ohms resistance to prevent interference with certain tests of the sleeve which the marker must make on no test calls.

Incoming trunk circuit T relay operates.

The B resistance is placed in series with the T relay operating circuit to prevent conflict with the direct battery which the terminating sender applies to the CO lead and to reduce current drain.

Ground is connected to the ST lead to the test frame.

The ground on the ST lead lights a lamp on the test frame as a signal that the call is completed. At this time the T and R leads from the test circuit are cut through in a clear metallic path to the called line. If for any reason it is desired to ring the subscriber, ringing current is applied by the operation of a key on the test frame.

DISCONNECTION

Disconnection at all times is under control of the subscriber line test circuit of the outgoing trunk test frame. When the test is complete, the removal of ground from the H lead causes the following:

Incoming trunk circuit H relay releases.

Incoming trunk circuit D relay releases.

Incoming trunk circuit RC, RV and TH relays (if operated) release in parallel.

Incoming trunk circuit T relay releases.

CALLED LINE BUSY

When the marker finds the called line busy it operates the RV and TC relays of the incoming trunk. These relays close through a circuit from the LB interrupter, to operate and release the incoming trunk circuit C relay. This intermittently grounds lead L to the test circuit causing a lamp to flash to indicate that the called line is busy.

OVERFLOW

If an overflow condition is encountered, the marker operates relays RC, RV and TC. These relays connect the OF interrupter through operating and releasing the trunk circuit C relay. This intermittently grounds the L lead to the test circuit flashing a lamp as a signal of the overflow condition.

CONTROLLER CIRCUIT MAKE BUSY JACK

A make busy jack, designated MB, is provided for each controller circuit to make that controller circuit busy for maintenance purposes. When a plug is inserted in the MB jack, the following occur:

Controller circuit MB relay operates.

Ground is connected to the G lead to the floor alarm board.

Ground on this lead lights a lamp on the floor alarm board as a visible indication of the controller circuit being made busy.

Ground is connected to the AL lead. The AL-1 and AL-2 leads are connected together.

The locking circuits of the TB-2 relay of the home frame and of the TA-2 relay of the mate frame are opened.

This is done because with a controller circuit made busy no emergency feature is available. Therefore, it is necessary that the "B" side of the home frame and the "A" side of the mate frame be returned to service immediately should a time out occur. If one occurs under this condition it will actuate a major alarm on both frames.

The operating circuits of the CA relay of the home frame and of the CB relay of the mate frame are opened.

The BC and CB leads and the BM and MB leads are connected together to provide an operating circuit for the CB relay of the home frame, independent of the condition of the mate frame.

Under this condition the normal contacts of the EA jack of the home frame and of the EB jack on the mate frame, are short-circuited, making these jacks ineffective.

The AC, CA and AM leads are connected together to provide an operating circuit for the CA relay of the mate frame, independent of the condition of the home frame.

HOLD JACK

A hold jack in the start circuit, designated HD, is provided for each controller circuit, for use for maintenance purposes to prevent a time out from automatically releasing the controller circuit. This feature is furnished as a maintenance aid so that a call will block at the stage where the trouble condition occurred. When a plug is inserted in the HD jack, the TA-1 and TA-2 relays and the TB-1 and TB-2 relays are prevented from operating. Under this condition, if a time out occurs, the frame is out-of-service and for this reason the HD jack should be used only under close maintenance supervision.

Even though the time alarm relays are prevented from functioning an alarm will be sounded (should a time out occur when a plug is in the HD jack).

MAJOR ALARM

This alarm consists of the lighting of the M lamp on the sender link frame and the ringing of the major alarm at the floor alarm board. This is accomplished by the operation of the MA relay which can operate due to any one or all of the following reasons:

a. Both controller circuits of a pair of link frames, arranged to work as mates, are made busy. Each MB relay is operated and grounds its AL lead and connects its AL-1 and AL-2 leads together. This results in the operation of the MA relay of each frame, and the lighting of the M lamp of each frame in addition to sounding the major alarm.

b. If a time out occurs while either controller circuit of a pair is made busy, either of two conditions result. If the time out is on the frame that is made busy, the operation of its TB-1 relay will cause its MA relay to operate. If the time out is on a frame whose mate circuit is made busy, the operation of the home frame TA-1 relay will cause the MA relay to operate. In either case the MA relay performs the functions previously described.

c. If a time out occurs while a plug is inserted in the HD jack the closure of the F contact of the IA or IB interrupter, after the TA or TB relay has operated, operates the MA relay which functions. Whenever the MA relay operates, it locks under control of the TR key. The TR key must be operated in order to release the MA relay, extinguish the M lamp and silence the major alarm.

EXERCISE JACKS

Exercise jacks EA and EB are furnished in the start circuit as a means of taking the A or B side of the start circuit out-of-service or as a means of routining the "B" side, to insure that these relays are functioning properly. Otherwise, either chain of start relays could be out-of-service without an alarm indication since the working side would automatically serve the call.

A plug in the EA jack opens the operating circuit of the CB relay and prepares the operating path of the CA relay independently of the mate frame. The path for operating the CA relay is as follows: battery TA-2 relay released, winding of CA relay, released contacts of CB and DB relays, make contacts of EA jack, operated contacts of GA relays, released contacts of MB relay, release contacts of TA-1 relay, released contacts of TA-2 relay, to TR key ground. A plug in the EB jack opens the operating circuit of the CA relay and prepares the operating path of the CB relay through the mate frame.

If a trouble condition occurs while a plug is in either the EA or EB jack, an alarm is given by the TA-2 or TB-2 relay. Either of these relays operated short-circuits the exercise jack which was being used so that the associated start relays will automatically restore to service. Only one jack should be used on a frame at any one time. If both are used simultaneously, neither jack is effective as an exercise jack.

ALL SENDERS BUSY WITHIN A SUBGROUP OS 414

Located on the terminating trouble indicator frame is a make busy jack for each subgroup of terminating senders in the office. When a plug is inserted into one of these jacks, the associated subgroup circuit GMB relay operates. The GMB relay in operating, operates the subgroup circuit AGB or BGB relays, or both if required. No traffic registers are scored at this time, since the GMB relay in operating removes ground from the SG lead to the traffic register circuit.

The AGB and BGB relays also operate through a chain circuit of the SB relays, when all associated senders in a subgroup become busy. Under this condition the SGT or SGB lead is grounded to the traffic register circuit for scoring a register, from ground on the normal contacts of the GMB relay.

Under any conditions, when the AGB or BGB relay operates, the AMB or BMB relays, respectively, operate on all sender link frames having the associated subgroup of senders. The operation of the AMB or BMB relay, open all the PA leads associated with links having access to this subgroup, thereby removing the subgroup of senders from preference.

LAST PATH TO IDLE SENDER SUBGROUP CEASES TO BE AVAILABLE OS 414

If the last path to a sender subgroup ceases to be available to the selected trunk group because all senders became busy, the following release takes place.

When all senders in the subgroup are busy, the AGB relay will operate. The AGB relay in turn operates the associated AMB relay which opens the PA leads. This will cause the TC relay to release and extend the locking ground of the TT relay to the winding of the RL relay. The RL relay operated, operates the RA relay and the controller releases as in a regular call.

TERMINATING SENDER INTERDIGITAL TIME OUT
MIN. 3.014 SEC. - MAX. 6.240 SEC. OS 411

The purpose of this feature is to reduce terminating sender holding time in an emergency when all senders are busy and partial dials are encountered.

The interdigital time out starts from the condition of all senders in each subgroup circuit indicating all senders busy. The all senders busy conditions must last for a longer period that 5 to 12 seconds before the interdigital feature is brought into operation, this being controlled by the terminating sender timing control circuit.

This feature will only effect those terminating sender calls that have an interruption between any selection for a period of 3 to 6 seconds, during the all senders busy condition. This timing period will naturally affect those terminating calls that have calling subscribers who are slow dialers. Slow dialing into the originating senders affects the holding time of the crossbar terminating senders and adds to the seriousness of a high terminating traffic load. Therefore, it is the function of the interdigital time out feature to wipe out all terminating senders having a 3 to 6 second delay during the all senders busy indication.

When all the senders within a subgroup are being used, all SB and SB-1 relays are operated. The SB-1 relays form a chain circuit to operate their associated AGB-1 relay, which in turn operates the AGB-2 relay. When all sender subgroups are busy, all AGB-2 relays will be operated forming a chain circuit, connecting ground to the TGB-1 lead to the terminating senders timing control circuit.

Upon receiving ground on the TGB-1 lead it is the function of the timing control circuit to count 5 to 12 seconds and then connect the G and G1 leads together in all terminating senders. When this takes place, all terminating senders having their ON-2 relay operated with the TC-2 relay normal, connect ground to their IDT interrupter; but this ground is never effective while the L-1 relay is operated, because it will be shunted by the W resistance and battery.

In those terminating senders where delays are occurring in selections and the L-1 relay is released for a period of 3 to 6 seconds the IDT interrupter operates the TM-3 relay when its B contact closes. The TM-3 relay locks and then when the F contact closes the TRL relay operates restoring the terminating sender to normal and leaving the originating sender connected to the trunk. Subsequent closures of the fundamental at the originating sender may cause the reseizure of another terminating sender which will again time out in the same manner if the timing control circuit is still effective. In spite of this possibility, however, the holding time is less than that which would be required if the TS interrupter and relays TM-1 and TM-2 were controlling.

When the terminating sender TC-2 relay operates it disconnects the ground from the G lead, preventing any further operation of the time out, during the remainder of the sender functions.

ROUTINE TESTING OF TERMINATING AND "B" SENDERS FROM THE O.G.T. BOARD

In offices where the use of a terminating and "B" sender automatic test frame is uneconomical, SD fig. 12 is furnished between the group circuit and the subgroup connector circuit, in connection with the terminating and "B" sender test selection circuit of the O.G.T. board. This arrangement permits test calls to be originated at the O.G.T. board and directed to the particular sender to be tested.

When such a test call is originated, the selection circuit of the O.G.T. board connects ground to lead A and battery to lead B of fig. 12 thereby operating the B relay. It also connects the appropriate G-0 to 5 lead to the B-0 to 5 lead corresponding to the sender subgroup to which the call is directed. This action occurs the instant that the test circuit receives a ground signal over a TG lead associated with the group circuit that corresponds to the trunk group in which the test call is originated.

When the B relay operates it opens the sender subgroup test leads G-0 to G-5, thereby preventing two SG relays from operating. The remaining SG relay receives its operating circuit under control of the O.G.T. board selection circuit which has closed the proper G lead corresponding to the desired sender subgroup.

The circuit operation for such test calls is the same as for any regular call except that only one SG relay may operate. The O.G.T. board selection circuit is arranged to make all senders of the desired subgroup appear busy except the one to which it is directing the test call. In this manner the test call may be directed to any particular sender desired. When the test call has been served the B relay is released.

INCOMING TRUNK

TIMED RELEASE

Should the called subscriber fail to disconnect when the calling subscriber or operator has disconnected, the release of the incoming trunk D relay, with the trunk S relay operated, connects ground to the A lead to the timing circuit for incoming trunks. When the S relay previously operated, it connected ground to the S-1 lead to the timing circuit, through normal contacts of a relay in the timing circuit, to the S lead to the incoming trunk from which point it was connected to the S lead to the incoming link circuit. This ground at the present time is holding operated the hold magnets of the established connection. After approximately 112 to 232 seconds have elapsed, the timing circuit functions and opens the above described path, thereby releasing the operated hold magnets. When the hold magnets release, the trunk circuit S relay releases and the trunk circuit is restored to normal.

Should the incoming trunk be seized before the timing circuit functions, a sender will be selected, selections and registration completed and a reverse battery and ground pulse transmitted to the originating sender, as for a regular call. The terminating sender releases the incoming trunk circuit T relay and connects battery to the CO lead. This battery prevents the operation of the trunk circuit T relay by shunting the battery on the primary winding when the terminating sender operates the trunk D relay. If this precaution was not taken the trunk T relay would operate after the D relay operates and cause a false charge, because the trunk circuit S relay is still operated from the previous call. With the battery shunt on the T relay preventing it from operating, the second call proceeds and the terminating sender summons a terminating marker connector and a marker to serve it. However, when the marker, on the second call, operates the incoming trunk circuit F relay, the S lead to the incoming link circuit is opened and the incoming and line link hold magnets operated for the previous call are released. The operation of the trunk F relay also causes the release of the S relay by transferring the T and R leads to the TT and RT leads. The marker continues to complete the second call in the same manner.

The subscriber on the first call having been disconnected from the incoming trunk, receives dial tone, due to the line link primary hold magnet being released.

CHAPTER 6

SECTION 4

METHOD OF OPERATION

FS Terminating Sender Circuit	SD-25013-01
Incoming Trunk Circuit	SD-25022-01
Timing Circuit for Incoming Trunk Circuit	SD-25038-01

MARCH 1954

FS TERMINATING SENDER REGISTRATION AND SELECTIONS

RELAYS AND MAGNETS OPERATED

At this point in the call the following relays and magnets are operated: incoming trunk circuit T relay, PH and SH hold magnets of the sender link and sender subgroup SB relay which are held operated under control of the terminating sender. The following terminating sender relays and magnets are operated: F-00 or F-10, RV-3, RV-4, RV-5, SM, RA-1, ON-1, ON-2, HM, one select magnet corresponding in number to the units digit of the incoming frame number, the F hold magnet, EF relay if the incoming frame number is even, the OA or OB relay if required, SPL relay if the incoming trunk requires the services of a special marker. The L relay may or may not be operated.

PREPARATIONS FOR SELECTIONS OS 417-418

The terminating sender is ready for a selection when the operating winding of the L relay is connected to the T lead without being shunted by the non-inductive winding of the incoming trunk A relay, and the winding of the STP relay is connected to the R lead without being shunted by a direct ground from the normal contacts of the L-1 and L-2 relays or by ground from the incoming trunk circuit D relay while the T relay is normal. Although ready when in that condition, it will not actually begin pulsing on the first selection until the incoming trunk T relay has operated and removed the trunk circuit battery and ground, or on any subsequent selection until the originating sender is ready with its circuit closed through its STP and OF relay windings.

To get ready for the first selection the ON-1 relay must be operated to cut through the T and R leads to the L and STP relays. The reason for this is to insure against interference with another terminating sender in case of a double connection at the sender link. The ON-1 relay does not operate until the terminating sender link and controller circuit has satisfied itself that there is no double connection. The terminating sender then waits for the SC-1 relay to release and operate the incoming trunk circuit T relay. When the T relay operates as described in Step 1, the following occurs simultaneously.

Terminating sender circuit L relay operates and the originating sender STP relay holds in series.

> The operating circuit of the L relay is as follows:
>
> Battery through the inductive and non-inductive windings of the L relay, connected in parallel through the contacts of the L-1 relay normal, operated contacts of the RV-3 relay, normal contacts of the IF-1 relay, normal contacts of the RV-1 relay, operated contacts of the ON-1 relay to the T lead to the sender link, through the operated link crosspoints, to the T lead to the originating office, through the windings of the originating sender STP and OF relays to the R lead to the incoming trunk, through the operated link crosspoints to the R lead of the terminating sender, operated contacts of the ON-1 relay, normal contacts of the RV-2 relay to ground on the normal contacts of the L-1 and L-2 relays.

Should the L relay operate before the T relay is operated, it then receives its operating ground from the normal contacts of the incoming trunk D relay.

The terminating sender circuit STP relay is shunted at this time by the normal contacts of the L-1 and L-2 relays.

Terminating sender circuit L-1 relay operates and locks.

The non-inductive winding of the L relay is disconnected from the T lead.

Ground is removed from the R lead.

Even though this ground is removed from the R lead, it is still grounded and the STP relay is still short-circuited by ground on the normal contacts of the L-2 relay.

Terminating sender circuit L-2 relay operates and locks.

The operating circuit of the L-1 relay is opened.

Ground is removed from the R lead.

If the T relay of the incoming trunk circuit has not operated by this time, removal of this ground from the R lead has not effect as the STP relay of this sender will still be short-circuited by ground connected to the R lead from the incoming trunk D and T relays normal. If and when the T relay of the incoming trunk is operated removal of ground from the R lead by the operation of the L-2 relay removes the shunt from the STP relay which will start the terminating sender to function.

Terminating sender circuit SM relay and the operated select magnet release.

On some short loops, the L relay can operate when the ON-1 relay closes through the T and R leads, in which case, the SM relay and select magnet will release upon the operation of the HM relay. On long loops the L relay will not operate until the trunk T relay operates, thus, the release of the SM relay and the select magnet is delayed until the L-2 relay operates.

The locking circuit of the L-2 relay is opened.

The L-2 relay does not release at this time as its original operating circuit is still effective.

Terminating sender circuit RA-2 relay operates.

Due to removal of short-circuit.

The RA-1 relay remains locked in parallel with the RA-2 relay.

Terminating sender circuit HM relay releases.

REGISTRATION AND COUNTING OF PULSES

On the first selection the L relay may operate as soon as it is cut through to the trunk or it may wait until the trunk T relay has operated. However, for subsequent selections it operates as soon as the originating sender is ready. The L relay operates with its non-inductive winding shunting its active winding. This is unimportant on the first selection, but on later selections the distant STP relay operates in series with it, and the non-inductive winding serves to smooth out the descending side of a cable capacity surge, which has a tendency to operate the STP relay of the originating sender momentarily. The L-1 relay in operating removes this non-inductive winding from the circuit in order to speed up the subsequent operations of the distant STP relay.

The L-1 relay operates through operated contacts of the SM relay, and the L-2 relay locks to the operated contacts of the SM relay. The reason for this arrangement is to prevent a selection from starting before the preceding one has progressed far enough in its registration to avoid possible interference, and yet to allow two selections to overlap one another as much as possible.

When the L, L-1 and L-2 relays have operated the terminating sender is ready for a selection. The reason for having parallel ground connections to the R lead from the normal contacts of the L-1 and L-2 relays is as follows: On their operation ground must be finally removed by the L-2 relay, because if it were removed by the L-1 relay at the same time that it removes the L relay non-inductive winding from the circuit, the STP relay of the originating sender might release falsely from having too much inductance placed in the circuit at one time. On the other hand, on the release of the L-1 and L-2 relays, release of the L-2 relay may be delayed and it is necessary to short-circuit the STP relay of this sender at once when the L and L-1 relays release, to prevent a chance of starting the next selection prematurely.

The maximum number of pulses for the first selection is five. However, in the following circuit operations the generation and counting of the maximum number of pulses, that may be required on later selections is used in order to complete this part of the circuit operation.

FIRST PULSE

With the incoming trunk T relay operated, when the terminating sender circuit L-2 relay operates and removes ground from the R lead the following occurs:

Terminating sender circuit STP relay operates.

> The terminating sender STP relay is operated in series with the originating sender STP relay and the terminating sender L relay. There are five relays involved in preparation for a selection; the terminating sender L, L-1 and L-2, the originating sender STP and the terminating sender STP. The order of operation of the first four relays may vary, but the terminating sender STP relay is always the last of the five to operate.

Terminating sender circuit GR and L-3 relays operate, L-5 relay is short-circuited.

Terminating sender circuit STP relay releases, the L relay holds and the originating sender STP relay releases. OS 418

The GR relay when operated connects ground to the T lead which holds the terminating sender L relay operated, shunts down the originating sender STP relay and returns on the R lead to shunt the terminating sender STP relay in series. This operation and release of the two STP relays constitutes the first pulse. This pulsing continues until the originating sender opens the fundamental circuit. The speed of pulsing depends upon the length of the trunk, a long trunk slowing down the speed of operation of the two STP relays to about the same degree.

In order to extend the life of the contacts of the terminating sender STP relay the direction of current flow is reversed on all calls which come from even numbered incoming link frames, the EF relay being operated on such calls.

Terminating sender circuit GR relay releases.

Terminating sender circuit L-5 relay operates and the L-3 relay locks, in series.

The ground for holding the L-3 and L-5 relays in series is furnished by make contacts of the L-1 and L-2 relays so that the L-3 and L-5 relays will release after the last pulse of a selection, should they be operated. The reason for connecting these make contacts of the L-1 and L-2 relays in parallel is as follows: The L-1 relay operates first, and by having it supply a locking ground there is better assurance that it will be ready in time than if reliance were placed on a possible vibrating contact of the L-2 relay alone. On the other hand, on the release of the L-1 and L-2 relays, the L-2 relay may be delayed and it is necessary to hold the locking ground until it releases, or else an additional P relay might be operated from the normal contact of the L-5 relay.

Terminating sender circuit P-1 relay operates and locks.

The operating ground for the P relays is supplied through make contacts of the L-2 relay to allow sufficient time to operate the last P relay on the last pulse of a selection. For this reason the L-2 relay is made slow release while the L-1 relay is fast release because it must release before the L relay operates for the next selection.

The locking ground for the P relays is supplied through a make contact of the L-2 relay and the normal contact of the SM relay in parallel. The contact of the SM relay holds the locking circuit until the select magnet is operated and locked. The contact of the L-2 relay holds the locking circuit through the interval during which the SM relay has not yet released from the previous selection. Because of this latter arrangement the L-2 relay is always locked until the SM relay releases from the previous selection.

Terminating sender circuit STP relay and originating sender STP relay operate in series with the operated L relay of the terminating sender.

Terminating sender circuit GR relay operates.

Terminating sender circuit L relay holds.

Terminating sender circuit L-4 relay operates and the L-5 relay locks, in series.

Terminating sender circuit L-4 relay locks.

The L-4 relay locks through the operated contacts of the L-3 relay.

Terminating sender circuit L-3 relay releases.

The locking circuit of the L-4 relay is opened.

The L-4 relay does not release at this time as it is held operated in series with the locking circuit of the L-5 relay. The reason for locking the L-4 relay to the L-3 relay operated is to prevent the possibility of registering a false pulse. If the L-3 relay were slow, or failed to release, the release of the L-4 relay would cause the re-operation of the L-5 relay and, thereby register two pulses instead of one.

Terminating sender circuit STP relay releases, the L relay holds and the originating sender STP relay releases.

The GR relay in operating connects ground to the T lead causing the above functions in the same manner.

Terminating sender circuit GR relay releases.

Terminating sender circuit L-4 and L-5 relays release.

Terminating sender circuit P-2 relay operates and locks.

Terminating sender circuit P-1 relay releases.

At the end of the second pulse the L-3, L-4 and L-5 relays are released, which was the position of these relays at the start of pulsing, the P-2 relay is operated and the P-1 relay has released.

COUNTING THE REMAINING PULSES

The terminating sender counts the pulses on the P-1 to P-6 relays, actuating them by the L-3, L-4 and L-5 relays. The periodical operation and release of the GR relay causes the two STP relays to release and re-operate, and also causes the operation and release of the L-3, L-4 and L-5 relays in a recurrent cycle.

The operation of the GR relay on the first, or any odd numbered pulse, operates the L-3 relay; its release permits the L-5 relay to operate in series with the L-3 relay. The operation of the GR relay on the second, or any even numbered pulse, operates the L-4 relay in series with the secondary winding of the L-5 relay, whereupon the L-3 relay releases but the L-5 relay holds. Release of the GR relay releases the L-4 and L-5 relays. Therefore, the L-5 relay is operated at the end of each odd pulse and releases at the end of each even pulse.

The L-5 relay, operated and released on successive pulses, closes two leads alternately to the pulse counting relays P-1 to P-6. These operate, lock and release in accordance with the number of pulses generated.

When the L-5 relay operates for the third pulse.

Terminating sender circuit P-2 relay releases.

Terminating sender circuit P-4 relay operates and locks.

When the L-5 relay releases for the fourth pulse.

Terminating sender circuit P-3 relay releases.

Terminating sender circuit P-5 relay operates and locks.

When the L-5 relay operates for the fifth pulse.

Terminating sender circuit P-4 relay releases.

Terminating sender circuit P-6 relay operates and locks.

When the L-5 relay releases for the sixth pulse.

Terminating sender circuit P-1 relay operates and locks.

When the L-5 relay operates for the seventh pulse.

Terminating sender circuit P-5 relay releases.

Terminating sender circuit P-2 relay operates and locks.

When the L-5 relay releases for the eighth pulse.

Terminating sender circuit P-1 relay releases.

Terminating sender circuit P-3 relay operates and locks.

When the L-5 relay operates for the ninth pulse.

Terminating sender circuit P-2 relay releases.

Terminating sender circuit P-4 relay operates and locks.

When the L-5 relay releases for the tenth pulse.

Terminating sender circuit P-3 relay releases.

If due to a trouble or for other reasons an eleventh pulse should be generated, the operation of the L-5 relay for that pulse results in the operation of the TT relay.

The above operations are for a series of ten pulses, which would occur for a number nine selection. If less than ten pulses are required these operations are terminated at a correspondingly earlier point.

The relays left locked up after each pulse, any one of which may be the last pulse of a selection, are as follows:

PULSE	RELAYS	PULSE	RELAYS
1	P-1	6	P-5, P-6
2	P-2	7	P-1, P-6
3	P-3	8	P-2, P-6
4	P-4	9	P-3, P-6
5	P-5	10	P-4, P-6
		11	P-4, P-6, TT

REGISTRATION OF SELECTIONS

There are five selections registered on each call, incoming brush and group, final brush, tens and units which are registered in that order, one after the other. Each selection is registered by operating one of the ten select magnets and then operating the hold magnet for that selection, after which the select magnet is released. This closes the crosspoint contacts at the level of the operated select magnet and on the proper register.

INCOMING BRUSH SELECTION AND REGISTRATION

The L relay is operated for incoming brush selection, described under preparation for selections. When the call advanced to the point at which the incoming trunk T relay and the terminating sender L-2 relay were operated, the STP relays of both senders and the L relay of the terminating sender were connected in series. The operation of the terminating sender STP relay caused the sender circuit to generate and count pulses. When the originating sender counts the proper number of pulses according to its registration, (both STP relays being released at that moment) it opens the fundamental circuit causing the following:

Terminating sender circuit L relay releases.

Terminating sender circuit L-1 relay releases.

The non-inductive winding of the terminating sender circuit L relay is connected in parallel with its inductive winding.

At this time if the originating sender again closes the fundamental, the terminating sender L relay and originating sender STP relay can be operated in series for the next selection. However, the L-1 relay can not operate even if the L relay does operate, as the L-2 relay is still operated.

Terminating sender circuit L-2 relay releases.

The L-2 relay will release after the L-1 relay releases, provided that the SM relay is normal from the previous selection, otherwise it will remain locked.

The P relays do not release at this time. They are still locked and remain so until the SM relay is operated, during the registration of this selection.

Terminating sender circuit L-3 and L-5 relays, if operated, release.

A terminating sender circuit select magnet operates.

There are ten select magnets, designated 0 to 9. The one that operates is the one whose number is one less than the number of pulses counted. For example, for incoming brush selection 4, even though five pulses have been counted, the number four select magnet is operated.

Terminating sender circuit SM relay operates.

The operated select magnet and the SM relay lock in parallel.

The above locking circuit is traced through the normal contacts of both the HM and L-2 relays in parallel.

The operating circuits for the select magnets are taken through four different normal contacts of the L-2 relay instead of a single normal contact, so that if the L-2 relay operates to start the next selection while a select magnet and the SM relay are still locked, and two adjacent P relays are both momentarily operated, the locking ground for the operated select magnet can not find a path to operate another select magnet.

Terminating sender circuit operated P relays release.

The operating circuit for the select magnets is taken through a normal contact of the SM relay so that if the P-6 relay releases faster than the other operated P relay, momentarily closing an operating path to another select magnet, there will be no ground on that path.

Terminating sender circuit L-1 relay operates and locks.

The L-1 relay operates at this time provided that the L relay is operated for the next selection.

Terminating sender circuit L-2 relay operates and locks.

The L-2 relay locks to the operated SM relay.

Terminating sender circuit STP relay operates, the originating sender STP relay and the terminating sender circuit L relay holds, in series.

The operation of the L-2 relay removes ground from the R lead permitting the operation of the STP relay of this sender. When the STP relay operates this circuit functions to generate and count pulses, even though the registration of the first selection is not as yet completed.

Terminating sender circuit RA-1 relay is short-circuited and releases.

Terminating sender circuit RA-2 relay holds.

Terminating sender circuit IB hold magnet operates and locks.

The conditions for operating the IB hold magnet are somewhat different than those used to operate the F hold magnet. Operation of the F hold magnet was due to the ON-2 relay operating and connecting ground to the primary winding of the HM relay. The release of the RA-1 relay controls the operation of the IB hold magnet by connecting its winding in parallel with the secondary winding and in series with the primary winding of the HM relay, the circuit conditions being the same for preventing the HM relay from operating.

The crosspoint contacts are closed, at the level of the operated select magnet.

The closure of the crosspoint contacts grounds receiving leads to the terminating marker connector circuit. The possible different combinations of these leads are described later.

Terminating sender circuit RV-3 relay locks.

The closure of the crosspoints of incoming brush vertical prepare a circuit for locking the RV-3 relay if the L relay is released or each time the L relay releases in each of the next succeeding selections. The purpose for locking the RV-3 relay is explained later.

Terminating sender circuit HM relay operates.

The locking of a hold magnet short-circuits the primary winding of the HM relay and being differentially wound and with only one winding energized at this time, it operates.

The operated terminating sender circuit select magnet and the SM relay release.

The select magnet and the SM relay release at this time provided that the L-2 relay is operated for the next selection.

Terminating sender circuit RA-2 relay releases.

Terminating sender circuit HM relay releases.

REGISTRATION OF THE REMAINING SELECTIONS

The remaining selections are registered in the same manner as the one previously described. During the registration of each selection the L, L-1 and L-2 relays can be operated, and start generating and counting the pulses for the succeeding selection.

When the SM relay operated for the first time, during registration of the incoming frame number, it operated the RA-1 relay, and when it released the RA-2 relay operated. The second time the SM relay operated (for incoming brush selection) it released the RA-1 relay, and when it released it caused the release of the RA-2 relay. That completed one cycle of the RA-1 and RA-2 relays and for the four subsequent selections, that cycle is repeated twice more.

Each time the SM relay operates, it either operates the RA-1 relay and leaves the RA-2 relay normal, or it releases the RA-1 relay and leaves the RA-2 relay operated. In either case, the effect is to connect the windings of the HM relay to the winding of the first non-operated hold magnet causing the same to operate.

Each time the SM relay releases, it either operates the RA-2 relay and leaves the RA-1 relay operated, or it releases the RA-2 relay and leaves the RA-1 relay normal. In either case, the effect is to disconnect the windings of the HM relay from any hold magnet, thereby releasing the HM relay.

The operation of the select magnet and the other terminating sender circuit functions are the same for the remaining selections as for the one described. The hold magnets for the remaining selections are operated.

Terminating sender circuit RA-1 relay operates and the RA-2 relay is short-circuited.

When the SM relay operates for incoming group registration.

Terminating sender circuit IG hold magnet operates and locks, and the HM relay remains normal in series.

Terminating sender circuit HM relay operates.

The operated terminating sender circuit select magnet and the SM relay release.

Terminating sender circuit RA-2 relay operates and the RA-1 relay holds, in parallel.

Terminating sender circuit HM relay releases.

Terminating sender circuit RA-1 relay is short-circuited and releases, and the RA-2 relay holds.

When the SM relay operates for final brush registration.

Terminating sender circuit FB hold magnet operates and locks and the HM relay remains normal in series.

Terminating sender circuit HM relay operates.

The operated terminating sender circuit select magnet and the SM relay release.

Terminating sender circuit RA-2 relay releases.

Terminating sender circuit HM relay releases.

Terminating sender circuit RA-1 relay operates and the RA-2 relay is short-circuited.

When the SM relay operates for final tens registration.

Terminating sender circuit FT hold magnet operates and locks, and the HM relay remains normal in series.

Terminating sender circuit HM relay operates.

The operated terminating sender circuit select magnet and the SM relay release.

Terminating sender circuit RA-2 relay operates and the RA-1 relay holds, in parallel.

Terminating sender circuit HM relay releases.

Terminating sender circuit RA-1 relay is short-circuited and releases, and the RA-2 relay holds.

When the SM relay operates for final units registration.

Terminating sender circuit FU hold magnet operates and locks, and the HM relay remains normal in series.

Terminating sender circuit HM relay operates.

The advance of the terminating sender circuit from this point is continued under incoming advance.

SYNCHRONIZATION OF SELECTIONS

The control of selections is primarily in the originating sender. It holds the fundamental circuit closed until it has counted the correct number of pulses, then it holds it open while it performs several internal functions to get ready for the next selection, then it recloses it. However, in order to prevent selections from succeeding each other too rapidly to be registered properly in the terminating sender, the latter must have check on the operations.

The operations necessary to transmit and record each selection consist of two parts. The first part is pulsing, which consumes variable time depending upon the number of pulses and the speed of pulsing, which in turn depends upon the length of the trunk. The second part is the registration of the selection on the crossbar switch, which consumes a fairly constant time.

There are two requirements to be met. The first, which is essential, is that selections shall not follow each other too rapidly to be properly registered, each in its turn. The second, which is not as important as the first, is to keep down the time needed to transmit and record the five selections.

If the control were left entirely to the originating senders, with no check by the terminating sender, the second requirement would be met to the greatest extent. If all selections were of maximum length, this might work satisfactorily on the assumption that the pulsing would take more time than registration. Then each selection would be registered while the succeeding one was being pulsed. However, a series of short selections of minimum length would run too rapidly for registration on the crossbar switch and in such a case, the first requirement would not be met.

In order to meet the first requirement, the terminating sender could be arranged so as not to permit any selection to start pulsing until the preceding selection had been registered. Obviously, with a proportion of long selections this would make the total time required much longer than if pulsing and registration were allowed to proceed simultaneously. Therefore, as a compromise, this circuit is arranged to allow a certain amount of overlapping, but with sufficient control by the terminating sender to prevent any loss of registration.

Assume a series of short selections. The originating sender counts the first set of pulses and breaks the fundamental circuit. The pulses are also counted on the P relays, and when the circuit is broken the L, L-1 and L-2 relays release, a select magnet and the SM relay must operate, the RA-1 relay must operate or release and a hold magnet and the HM relay must operate in order to completely register this selection. However, before all this can occur the fundamental circuit is closed again and the L relay operates. The next series of pulses must not start until the P relays are released, and they must not release until the select magnet and the SM relay are safely operated. Therefore, to accomplish this, the release of the P relays and the operation of the L-1 relay (for the next selection) are both delayed until the SM relay operates, the P relays locking through a normal contact of the SM relay, and the L-1 relay operating through an operated contact of the same relay.

When the SM relay operates for the first registration, the L-1 and L-2 relays operate and pulsing starts for the second selection. The originating sender counts the pulses of the second selection, opens the fundamental circuit and recloses it for the third selection. The pulses of the second selection, as before are counted on the P relays and when the fundamental circuit is opened the L and L-1 relays release. However, the second selection can not proceed to the point of operating a select magnet until a hold magnet has been operated on the first registration. To accomplish this, the release of the L-2 relay (on the second selection) is delayed until the SM relay (on the first registration) releases, by locking it to a make contact of the SM relay; and the release of the SM relay (on the first registration) is delayed until the HM relay operates, (on the first registration) by locking it to a normal contact of the HM relay.

The L-1 relay can operate only when the SM relay is operated. In a case in which a selection is completely registered before the originating sender closes the fundamental circuit for the next selection, the HM relay will have operated and opened its locking circuit for the SM relay. If the SM relay is permitted to release at this time, there would be no circuit to operate the L-1 relay when the L relay operates later for the next selection. To prevent this from happening, the SM relay is also locked through a normal contact of the L-2 relay, so that the SM relay can not release from one selection before the L, L-1 and L-2 relays have operated for the next selection.

The L-2 relay can release only upon the release of the SM relay. This might lead to a condition where the originating sender opens the fundamental circuit releasing the L and L-1 relays, but the L-2 relay can not release because the SM relay is operated. If during the above situation, the originating sender were to close the fundamental circuit operating the L and L-1 relays, without the L-2 relay having had any opportunity to release and start a registration, one retistration would be lost. To prevent this from occurring, the operating path for the L-1 relay is taken through a normal contact of the L-2 relay.

INCOMING ADVANCE

When the last selection has been transferred from the originating sender to the terminating sender, the fundamental circuit is opened resulting in the release of the L relay. When the L relay releases upon the completion of final units, selection, the following occurs:

Terminating sender circuit L-1 relay releases.

> The non-inductive winding of the L relay is connected in parallel with the inductive winding.

Terminating sender circuit L relay and originating sender STP relay operate in series.

> This can occur at this time provided that the originating sender has closed the fundamental circuit for incoming advance. The originating sender OF relay will not operate as the current is not in the proper direction and the operation of the originating sender STP relay results in no action in that sender. The terminating sender STP relay does not operate for incoming advance.

Terminating sender circuit L-2 relay releases.

The L-2 relay releases at this time provided that the SM relay has released on final tens selection.

A terminating sender circuit select magnet operates.

The select magnet to operate is numbered one less than the number of pulses generated for final units selection.

Terminating sender circuit SM relay operates and locks.

The operated select magnet locks in parallel.

Terminating sender circuit L-1 relay operates and locks.

Provided that the L relay has operated.

Terminating sender circuit L-2 relay operates and locks.

Terminating sender circuit RA-1 relay is short-circuited and releases.

Terminating sender circuit RA-2 relay holds.

Terminating sender circuit operated P relays release.

Terminating sender circuit FU hold magnet operates and locks.

Terminating sender circuit STP relay is short-circuited and ground is connected to the R lead in parallel.

Even though this ground will later be transferred to the T lead, internally in this sender it will still be on the R lead, thereby keeping the STP relay short-circuited preventingits operation during incoming advance.

Terminating sender circuit HM relay operates.

Terminating sender circuit RV-1 relay operates and locks.

The RV-1 relay can operate provided that the L-2 relay is operated, indicating that the originating sender has closed the fundamental circuit for incoming advance. The fundamental circuit can be closed and effective anytime after the release of the L-1 relay upon the completion of final units selection. The advance of this circuit when this condition is not met.

The FC lead is disconnected from the winding of the SPL relay.

Ground is connected to the T lead.

The ground that was previously connected to the R lead by the FU hold magnet is still present. The grounding of the T lead by the operation of the RV-1 relay results in the release of the STP relay of the originating sender. However, this causes no action in the originating sender. The operation of the RV-1 relay extends the R lead ground to the winding of the terminating sender L relay holding it operated. During the short space of time while these two leads remain grounded, the cable is discharged, the distant STP relay is de-energized and the terminating sender L relay is heavily energized.

Terminating sender circuit RV-2 relay operates.

The RV-2 relay is slow operate in order to maintain the ground both sides condition sufficiently long for it to accomplish the previously mentioned functions.

The operated terminating sender circuit select magnet and the SM relay release.

Provided that the L-2 relay is operated for incoming advance.

Terminating sender circuit RA-2 relay releases.

Terminating sender circuit L relay holds and the originating sender STP and OF relays operate in series.

When the RV-2 relay operates ground is removed from the R lead and the L relay winding is connected to it holding the L relay operated due to the make before break contacts of the RV-1 relay. This constitutes the reverse battery and ground pulse needed to advance the originating sender. The current starts suddenly on account of the heavily soaked condition of the L relay. The purpose of allowing the L relay to become soaked before connecting it to the R lead is to compensate for a tendency under certain conditions for the OF relay (of the originating sender) to operate faster than its associated STP relay.

Terminating sender circuit RV-3 relay releases.

The RV-3 relay will release at this time provided the originating sender has closed the fundamental circuit for incoming advance and has received the reverse battery operating the L relay. The RV-3 was locked through the crosspoints of the incoming brush vertical to insure that the fundamental is closed for incoming advance before the reverse battery is disconnected from the fundamental circuit.

The RV-3 relay is slow release in order to hold the above reverse battery and ground condition on the R and T leads, respectively, for a sufficient time for it to be effective in the originating sender. The release of the RV-3 relay results in simultaneous circuit operations, namely, removal of the reverse battery and ground and the start of trunk closure. The removal of the reverse battery and ground is considered first.

Terminating sender circuit L relay and the originating sender STP relays release.

The release of the RV-3 relay removes ground from the T lead and the L relay from the R lead, causing the above relays to release, indicating the termination of the reverse battery and ground pulse.

Terminating sender circuit L-1 relay releases.

Terminating sender circuit L-2 relay releases.

TRUNK CLOSURE

Following the transmission of the reverse battery and ground pulse, the terminating sender advances so as to check that the incoming trunk closure has been effected at the originating end, before summoning a terminating marker to serve this call. When the RV-3 relay released, simultaneously with the removal of reverse battery and ground the following occurs:

Terminating sender circuit RV-4 relay releases.

Battery is connected to the T lead.

Battery is connected to the R lead.

The T lead is connected to battery through the CO resistance lamp, while the R lead is connected to the resistance battery feed from the RV-5 relay. The connection of the above two batteries serves to discharge the trunk cable from the preceding reverse battery and ground pulse.

Incoming trunk circuit T relay releases.

The release of the terminating sender RV-4 relay removes ground from the CO lead through the sender link to the incoming trunk. This releases the trunk circuit T relay, causing the A relay to be closed back to the trunk to await trunk closure, but with its secondary or P-2 winding connected to the R lead and short-circuited by direct ground from the D relay normal.

Terminating sender circuit RV-5 relay is short-circuited and releases.

The incoming trunk circuit T relay in releasing connects ground from the trunk circuit D relay normal, to the R lead to the sender link. This is extended to the sender, short-circuiting the RV-5 relay, thereby releasing it.

Resistance battery is connected to the CO lead.

This battery through the CO lamp is connected to the CO lead in order to prevent the incoming trunk circuit T relay from operating due to a condition local to the trunk. This is described in detail in Step 3.

Resistance battery is removed from the T and R leads.

Incoming trunk circuit D relay operates.

The terminating sender circuit RV-5 relay in releasing connects a low resistance ground to the winding of the TC-1 relay, which is already connected to a resistance battery. The other side of the TC-1 relay is connected to the D lead through the sender link to the D relay of the incoming trunk. The connection of this ground to the winding of the TC-1 relay causes the trunk circuit D relay to operate. The TC-1 relay does not operate at this time as it is polarized and the current flow is in the wrong direction.

The ST lead to the terminating sender link and controller circuit is opened.

Ground is removed from the PB lead to the traffic register circuit. (D)

The PB lead is used to actuate a traffic register, to record the number of times that all trunks of a group are busy. When ground is removed from this lead by all the trunks of a group, a relay releases and the register scores.

Ground is connected to the S lead to the incoming trunk circuit. (D)

Incoming trunk circuit A relay operates. (Originating office in trunk closure position)

At this time the incoming trunk circuit A relay operates due to the originating office closing the trunk. This relay could not have operated prior to this time even though the originating office was to make trunk closure due to any one or all of the following reasons: Prior to the operation of the trunk circuit D relay, the secondary winding of the A relay is short-circuited. Also, a battery is connected to both sides of the trunk, by the terminating sender, from the time that the trunk T relay is released until the D relay is operated. This short-circuit of the A relay secondary winding and the battery both sides condition is removed simultaneously with the operation of the D relay. This is done in order to have the D relay operated before permitting the operation of the A relay. If the sequence of these two relays were reversed, it would result in starting the sender link and controller circuit again on this call.

Terminating sender circuit TC-1 relay operates and the incoming trunk circuit D relay locks, in parallel. (A)

The operation of the trunk circuit A relay locks the D relay which extends the locking ground to the D lead through the sender link, to the terminating sender. This results in the operation of the TC-1 relay, as the current flow is now in the proper direction.

CONNECTION WITH TERMINATING MARKER - CONNECTOR AND TERMINATING MARKER

When the TC-1 relay operates, it signifies that trunk closure has been completed satisfactorily and that the originating office is still connected.

Terminating sender circuit TC-2 relay operates and locks.

Battery is connected to the ST lead to the terminating marker connector circuit. (TC-2)

The above battery on the start lead causes the terminating marker connector to function and select an idle terminating marker. The connector circuit connects the marker to the sender by 33 leads. If the SPL relay is operated the sender grounds the SPL lead resulting in the selection of a special marker.

If the terminating marker encounters any kind of difficulty in establishing the connection, the connector connects the terminating sender to another one for a second trial. The terminating sender is unaware of this substitution. The operation of the terminating marker connector will be discussed in Chapter 7.

INFORMATION FROM THE SENDER TO THE TERMINATING MARKER

The sender transfers to the marker the office identification signal, the number of the incoming frame involved and the called number as translated from the five selections, by grounding a selection of leads, OAB, F-1, F-2, F-4, F-5, F-10, TH-1, TH-2, TH-4, TH-8, H-1, H-2, H-4, H-5, T-1, T-4, T-5, U-1, U-2, U-4 and U-5. The leads not grounded are connected to the CK-1, CK-2, CK-3 or CK-4 leads. The RO lead, which is used by "B" senders, is permanently connected to the CK-3 lead in this sender.

The F register grounds leads F-1, F-2, F-4 and F-5 according to the incoming frame number.

Frame	Leads	Frame	Leads
0 or 10	None	5 or 15	F-5
1 or 11	F-1	6 or 16	F-1 and F-5
2 or 12	F-2	7 or 17	F-2 and F-5
3 or 13	F-1 and F-2	8 or 18	F-1, F-2 and F-5
4 or 14	F-4	9 or 19	F-4 and F-5

If the incoming frame number is 0 to 9, the F-00 relay connects the F-10 lead to the CK-4 lead, and if it is 10 to 19, the F-10 relay is operated and the F-10 lead is grounded, in addition to the above mentioned F leads.

If the OA relay is operated and a 0, 1, 2 or 3 is registered on the IG vertical the OAB lead is connected to the CK-3 lead. If the OA relay is operated and a 4, 5, 6, 7 or 8 is registered on the IG vertical, or if the OB relay is operated, the OAB lead is grounded.

The IB and IG registers ground leads TH-1, TH-2, TH-4 and TH-8 according to the thousands digit of the called number, which is translated from the incoming brush and group selections.

Thousands	IB	IG	Leads
0	0	0 or 1	None
1	0	2 or 3	TH-1
2	1	0 or 1	TH-2
3	1	2 or 3	TH-1 and TH-2
4	2	0 or 1	TH-4
5	2	2 or 3	TH-1 and TH-4
6	3	0 or 1	TH-2 and TH-4
7	3	2 or 3	TH-1, TH-2 and TH-4
8	4	0 or 1	TH-8
9	4	2 or 3	TH-1 and TH-8

The IG and FB registers ground leads H-1, H-2, H-4 and H-5 according to the hundreds digit of the called number, which is translated from the incoming group and final brush selections.

Hundreds	IG	FB	Leads
0	0 or 2	0	None
1	0 or 2	1	H-1
2	0 or 2	2	H-2
3	0 or 2	3	H-1 and H-2
4	0 or 2	4	H-4
5	1 or 3	0	H-5
6	1 or 3	1	H-1 and H-5
7	1 or 3	2	H-2 and H-5
8	1 or 3	3	H-1, H-2 and H-5
9	1 or 3	4	H-4 and H-5

The FT register grounds leads T-1, T-2, T-4 and T-5 and the FU register grounds leads U-1, U-2, U-4 and U-5, according to the tens and units digits, respectively, of the called number, which are the same as final tens and final units selections.

Tens or Units	FT	Leads	FU	Leads
0	0	None	0	None
1	1	T-1	1	U-1
2	2	T-2	2	U-2
3	3	T-1 and T-2	3	U-1 and U-2
4	4	T-4	4	U-4
5	5	T-5	5	U-5
6	6	T-1 and T-5	6	U-1 and U-5
7	7	T-2 and T-5	7	U-2 and U-5
8	8	T-1, T-2 and T-5	8	U-1, U-2 and U-5
9	9	T-4 and T-5	9	U-4 and U-5

When the sender and marker are first connected together, leads CK-1, CK-2, CK-3 and CK-4 are grounded in the marker, so that the marker relays connected to all the F, TH, H, T, U and RP leads operate. That closes chain circuits in the marker, with the effect of removing ground from the CK-1, CK-2, CK-3 and CK-4 leads. This releases all relays in the marker except those which are operated from ground from the terminating sender crossbar switch. The effect of first operating all relays in the marker and then releasing those not required, is to check all connecting leads for continuity and freedom from false grounds and crosses.

SELECTION OF INCOMING TRUNK BY THE TERMINATING MARKER

When the marker has received the information from the sender, it functions to establish a connection between the incoming trunk and the called line. During the marker functions ground is connected to the FC lead.

Incoming Trunk circuit F relay operates.

Ground connected to the FC lead by the marker is advanced to the terminating sender, through the marker connector circuit. From the sender this ground is connected to the FC lead to the sender link and thence to the incoming trunk operating the F relay.

Ground is connected to the PC lead to the traffic register circuit.

This ground is used to score a peg count register, to record the number of calls completed over the trunk from one office.

Ground is connected to the M1 lead to the incoming link circuit.

The M1 lead is provided on only 160 trunk incoming link frames and is used to operate the No. 0 or No. 1 primary select magnet. The No. 0 select magnet is operated by the even trunks which appear in the left half of the horizontal levels No. 2 to No. 9 and the No. 1 select magnet is operated by the odd trunks which appear in the right half of the horizontal level No. 2 to No. 9.

Ground is connected to the LC lead to the incoming link circuit.

This ground is used to operate a relay in the incoming link circuit, to aid the marker in its functions.

Incoming link circuit T and R leads are connected to the TT and RT leads, respectively. Incoming link circuit S and SL leads are connected.

The windings of the incoming trunk circuit RC, RV and TC relays are connected to the RC, RV and TC leads, respectively, to the incoming link circuit.

The last three functions are performed to aid the terminating marker circuit in its functions. The marker determines whether the called line is idle or busy and whether it is a free line, ring party line, tip party line or a P.B.X. line. On this call it is assumed that the called line is an idle ring party line. Under this condition, the marker connects ground to the RC lead.

Incoming trunk circuit RC relay operates and locks.

The locking ground of the RC relay is extended to the RC lead.

This ground is used by the marker as a check that the proper ringing control relay has operated.

RELEASE OF THE TERMINATING SENDER

After the terminating marker has removed ground from FC lead, releasing the trunk circuit F relay, it advances and ground the RL lead.

Terminating sender circuit RL relay operates and locks.

An additional ground is connected to the SB lead to the sender link and controller circuit.

This ground is provided to hold the sender subgroup circuit SB relay operated until the RL relay releases. The main purpose of this circuit arrangement is for a special test which the sender test frame makes over the common TR lead and then it checks for ground on the SB lead as an indication that the sender RL relay has operated.

Terminating sender circuit ON-1 relay and the operated sender link PH and SH hold magnets release.

The terminating sender ON-1 relay releases provided that the S lead to the sender link is not falsely grounded. On this call it is assumed that the S lead is clear. The action of the terminating sender when the S lead is grounded is considered later. The reason for holding the ON-1 relay over the HLD lead is to prevent the breaking of current by the terminating sender crossbar switch crosspoints.

CALLED SUBSCRIBER ANSWERS

The incoming trunk is at present ringing the called subscriber's bell. When the called subscriber removes the receiver from the switchhook in answer to the ring, the following occurs:

Incoming trunk circuit R relay operates.

Incoming trunk circuit RC relay releases.

Ringing current is removed from the called line and ringing tone is disconnected from the originating subscriber.

Incoming trunk circuit R relay releases.

Incoming trunk circuit S relay operates.

The release of the RC relay connects battery and ground from the windings of the S relay to the called subscriber's line with the receiver off the hook, operating the S relay. This battery and ground supplies talking transmission for the called subscriber and supervision for the terminating equipment.

Ground is connected to the S-1 lead to the timing circuit for the incoming trunks.

This ground passes through normal contacts of a relay in the timing circuit and returns on the S lead to the incoming trunk where it is connected in parallel with the ground that is already connected to the S lead to the incoming link circuit. Further functions of the timing circuit are described in Step 3.

Incoming trunk circuit T relay operates.

The operation of the S relay closes ground for operating the T relay through its secondary and primary windings. The release of the sender link hold magnets removed the battery from the CO lead which was shunting the T relay thereby permitting its operation at this time.

The battery and ground from the incoming trunk A relay to the originating office is reversed.

This reversal of battery and ground is a supervisory signal to the originating office that the called subscriber has answered. If the originating office is crossbar this signal causes the message register to be scored immediately or if panel, the district is set for scoring the message register at disconnection of the call.

The incoming trunk circuit A relay remains operated and the trunk is now ready for conversation to take place.

DISCONNECTION BY CALLED SUBSCRIBER

When the called subscriber replaces the receiver on the switchhook, the following occurs:

Incoming trunk circuit S relay releases.

Ground is removed from the S-1 lead to the timing circuit for the incoming trunks.

Incoming trunk circuit T relay releases.

The release of the T relay restores the battery and ground from the A relay to the originating office to its normal direction. The A relay remains operated.

DISCONNECTION BY CALLING SUBSCRIBER

When the calling subscriber disconnects the originating circuits advance opening the T and R leads to the incoming trunk circuit, causing the following:

Incoming trunk circuit A relay releases.

Incoming trunk circuit D relay releases.

Ground is connected to the PB lead.

Ground is removed from the S lead to the incoming link circuit.

Removal of this ground causes the established connection to release, by releasing the operated incoming link and line link hold magnets.

CALLED LINE BUSY

If the called line is busy, the marker will, at the time that the incoming trunk F relay is operated, connect ground to the RV and TC leads and, thereby operate the RV and TC relays, respectively. These relays when operated lock to ground through the make contacts of the D relay and provide a path for flashing the T relay at the rate of 60 interruptions per minute from interrupter lead LB. The flashing T relay intermittently reverses the battery and ground from the A relay to the originating office as a busy supervisory signal. At the same time interrupter low tone over lead "A", from interrupter lead LBT, is connected through the make contacts of the RV and TC relays, through the A condenser to the originating office as a line busy signal to the calling subscriber. Disconnection in this case occurs only at the originating office and results in the release of the A, D, TC and RV relays, thereby restoring the trunk circuit to normal.

No hold magnets will have been operated on the incoming or line link frames.

CALL TO A FREE LINE

If the call is to a line on which no charge is to be made the marker will, after the F relay has operated, connect ground to the RC and TC leads causing the operation of the RC and TC relays, respectively. The call proceeds as for a regular call except that when the called subscriber answers, the ground from the make contact of the S relay is prevented from operating the T relay due to the TC relay being operated. The T relay remaining normal does not reverse the battery and ground to the originating office, thereby preventing a charge on this type of call. Disconnection occurs as in a regular call except that the release of the T relay is omitted and release of the TC relay is added.

ALL TRUNKS BUSY

If the marker is unable to establish the connection to the called subscriber because no line junctors, incoming links or line links are available it will, after the operation of the F relay, connect ground to the RC, RV and TC leads. This results in the operation of the RC, RV and TC relays, respectively. These relays when operated lock to ground at the make contacts of the D relay and provide a path for flashing the T relay at the rate of 120 interruptions per minute from interrupter lead OF. The flashing T relay reverses the battery and ground to the originating office as an overflow supervisory signal. At this time low tone over lead "A" from the OFT interrupter is connected through the make contacts of the RC, RV and TC relays to the originating office, as an overflow signal to the calling subscriber. Disconnection occurs for a called line busy. No hold magnets will have been operated on the incoming or line link frames.

CHAPTER 6

SECTION 5

MISCELLANEOUS INFORMATION AND FEATURES

FS Terminating Sender Circuit SD-25013-01

MARCH 1954

TELLTALE
SC ON OS 419, OS-417, 418 & 4.19

If a call is abandoned during selections, or if a trouble condition in the originating sender prevents it from opening the fundamental circuit when ten pulses have been generated for any selection, or if an incoming trunk with cross conductors seizes the terminating sender without having been called into service at its originating end, a telltale condition ensues. This condition is one where the pulses of a selection are allowed to run to 11, and is so called because a similar condition when a panel incoming or final selector is involved, instead of a crossbar terminating sender, drives the selector rod to the telltale position.

For any selection when ten pulses are generated the P-4 and P-6 relays are operated. When the L-5 relay operates upon the generation of the 11th pulse the following occurs.

The sender TT relay operates and locks for the 11th pulse which opens the start lead to the marker connector, the operating ground for operating the sender select magnets is removed and ground is connected to the "R" lead.

> The ground for operating a select magnet is supplied by a normal contact of the TT relay, so that when a telltale is encountered no select magnet will operate, thereby saving unnecessary wear on the crossbar switch.
>
> The operation of the TT relay connects ground to the R lead to hold the originating sender STP relay and the terminating sender L relay operated.

The terminating sender STP relay releases, the RV-1 operates and locks and ground is connected to the IF interrupter in parallel.

> The RV-1 relay operates through an operated contact of the L-2 relay. Inasmuch as this telltale condition was caused by the fundamental circuit failing to open, the L, L-1 and L-2 relays are operated at this time.

Ground is connected to the terminating sender circuit T lead.

> The ground previously connected to the R lead by the operation of the TT relay is still present. The ground connected to the T lead results in the originating sender STP relay releasing, provided an originating sender is attached. However, the release of the STP relay causes no action in the originating sender. The operation of the RV-1 relay extends the R lead ground to hold the terminating sender L relay operated. During the time that the T and R leads are grounded, the cable is discharged, the originating sender STP relay is de-energized and the terminating sender L relay is heavily energized.

Terminating sender circuit RV-2 relay operates.

The RV-2 relay is slow operate to allow sufficient time for the above to be completed.

Terminating sender circuit L relay holds operated and the originating sender STP and OF relays operate in series.

The operation of the RV-2 relay removes the ground from the R lead. This allows the L relay battery to become effective on the R lead to the originating sender. This constitutes a reverse battery pulse. The current starts suddenly because of the heavily soaked condition of the terminating sender L relay. The reason for this circuit arrangement is to compensate for a tendency, under certain conditions, of the originating sender OF relay to operate faster than its associated STP relay.

Terminating sender circuit RV-3 relay releases.

The RV-3 relay is slow release to allow sufficient time for the reverse battery and ground pulse to be effective in the originating sender.

Terminating sender circuit L relay and originating sender STP and OF relays release.

The release of the RV-3 relay removes ground from the T lead and the L relay from the R lead thereby causing the above functions and terminating the reverse battery pulse.

Terminating sender L1, L2, L3, RV-4 relays release.

The RV-4 relay is slow release in order to allow a short open period to permit the originating sender to function and open the incoming trunk at that end.

Battery is connected to the T lead.
Battery is connected to the R lead.

This battery condition discharges the cable from the preceding reverse battery and ground pulse.

Incoming trunk circuit T relay releases.

The RV-4 relay in releasing removes ground from the CO lead thereby causing the release of the incoming trunk circuit T relay.

Terminating sender RV-5 relay releases.

When the incoming T relay is released ground from the normal contacts of the D relay is extended to the R lead to the terminating sender, where it short-circuits the RV-5 relay causing it to release.

Battery is removed from the T and R leads. Incoming trunk circuit D relay operates.

> The RV-5 relay in releasing connects ground to the winding of the TC-1 relay. The battery that was connected to this winding by the release of the SC-2 relay is still connected. Connection of ground to the TC-1 relay winding results in operation of the trunk D relay. The TC-1 relay is polarized and does not operate at this time as the current flow is in the wrong direction.

Incoming trunk circuit A relay operates. (From trunk closure of the originating circuits)

> The operation of the A relay occurs approximately at this point. However, if the incoming trunk conductors were crossed or grounded, thereby causing the telltale, the A relay is prevented from operating prior to this time because of its secondary winding being short-circuited and the battery to both sides being applied by the terminating sender to the trunk before the operation of the D relay. If the sequence of the trunk circuit A and D relays were reversed, the terminating sender link and controller circuit would be re-started on the call. In cases where the incoming trunk conductors are in trouble, resulting in a telltale, there is a great possibility of operating the A relay before the D relay. Therefore the shunting of the A relay secondary winding and the connection of battery to both sides of the trunk prevents a series of sender link and controller circuit re-starts, when the trunk conductors are in trouble.

Terminating sender circuit TC-1 relay operates and the incoming trunk circuit D relay locks, in parallel.

Terminating sender TC-2 and RL relays operate and lock.

> The RL relay operates through operated contacts of the TC-2 and TT relays to ground through the normal contacts of the TM-2 relay. The terminating sender disconnects from this point as in a regular call. The P-4, P-6 and TT relays release when the ON-2 relay releases.
>
> If the call was from a panel office it will result in the calling subscriber receiving an overflow signal, whereas if the call was from a crossbar office the telltale causes the originating sender to proceed on a second trial basis. In either case the advance of the originating circuits opens the T and R leads.

Due to the advance of the originating circuits the incoming trunk A and D relays release.

OVERSTEP IN INCOMING BRUSH, GROUP OR FINAL BRUSH SELECTION

Oversteps in selections in most cases will result in connection to the wrong number. However, for incoming brush, group or final brush selection, an overstep in selections may result in the closure of crosspoints on the portion of the register that is not wired to the transmitting leads. If the call were permitted to proceed after such an overstep, it would result in a double terminating marker failure and consequently the incoming trunk circuit would be disconnected from the marker with only its A and D relays operated. This would result in the calling subscriber being connected through to the incoming trunk circuit and receiving no signal, such as audible ring, busy back or overflow.

To prevent this from occurring, when an overstep is registered on the nonwired portion of any of the three registers, the terminating sender is designed to function as follows.

The overstep is assumed to have occurred at incoming brush selection and when the originating sender is eventually satisfied the following occurs:

Terminating sender circuit L and STP relays and originating sender STP relay release. (Due to the originating sender opening the fundamental circuit)

Terminating sender circuit L-1 relay releases.

> The noninductive winding of the L relay is connected in parallel with its inductive winding.

Terminating sender circuit L relay and originating sender STP relay operate in series.

> The above operations can take place at this time, for the next selection, providing the originating sender closes the fundamental circuit.

Terminating sender circuit L-2 relay releases.

> The L-2 relay releases at this time provided that the SM relay has released from incoming frame registration, which is the assumed condition.

Terminating sender circuit L-3 and L-5 relays, if operated, release and a terminating sender circuit select magnet operates.

> The select magnet that operates is numbered one less than the number of pulses counted. This being an overstep at incoming brush selection, six to ten pulses have been counted. Consequently the select magnet that operates is numbered 5 to 9 respectively.

Terminating sender circuit SM relay operates and locks.

The operated select magnet locks in parallel. The operated terminating sender circuit P relays release.

When the term sender circuit L-1 relay operates and locks.

> The L-1 relay can operate at this time provided that the L relay is operated for the next selection.

The noninductive winding of the terminating sender circuit L relay is disconnected from the inductive winding and the terminating sender L-2 will operate and lock.

Terminating sender circuit STP relay operates in series with the previously operated originating sender STP relay and terminating sender L relay.

> The L-2 relay in operating disconnects ground from the R lead permitting the above operations to take place. At this time the terminating sender can generate and count pulses for the next selection, even though the overstep has not been registered.

Terminating sender circuit RA-1 relay is short-circuited and releases.

The terminating sender RA-2, RV-3 and IB hold magnet operate and lock.

> When the IB hold magnet operated, it closed a set of crosspoints on the nonused half of the vertical on the terminating sender crossbar switch. This closure results in a ground being closed through the crosspoints from the normal contacts of the L relay, if released, to lock the RV-3 relay. However, if the L relay is operated, this locking circuit is not effective until the L relay is released.

Terminating sender circuit HM relay operates.

The operated terminating sender circuit select magnet and the SM relay release.

Terminating sender circuit TT relay operates and locks.

> When the TT relay operates, the terminating sender circuit functions the same as described under "Telltale" with these exceptions.
>
> When the terminating sender STP relay is released the STP relay may be operated or it may be released at that particular time. This depends upon the number of pulses in the next succeeding selection or whether the originating sender has the fundamental circuit opened, due to getting ready for the next selection. Should the fundamental be closed and in the process of a selection when the TT relay operates, it holds the L relay and the originating sender STP relays operated, preventing any further pulsing. If the fundamental is opened, then the terminating sender STP and L relays will be released.

Should the L relay be released at the time the RV-2 relay operates and prepared the circuit for reverse battery to the originating sender, the RV-3 relay will be locked to the released contacts of the L relay as already described. This prevents the termination of reverse battery should the originating sender have the fundamental circuit opened when the RV-2 relay operates.

In view of the fact that the RV-3 relay is locked to the L relay normal contacts, it is not essential that the trunk conductors be discharged prior to the reverse battery and ground pulse. The RV-3 relay will remain operated and maintain this reverse battery and ground condition, until the L relay operates, which will be when the fundamental circuit is closed by the originating sender for the next selection and when any existent lag in the trunk conductors is overcome. No further selections can take place when the fundamental circuit is closed since the terminating sender TT relay is still operated. When the above two conditions are met, the sender proceeds as follows.

Terminating sender L relay and originating sender STP and OF relays operate in series operating the term sender L-1 relay provided the SM relay is operated.

Terminating sender L-2 operates and RV-3 and L relays release terminating the reverse battery and ground pulse to the originating office which causes the originating senders STP and OF relays to release.

The terminating sender L-1, L-2 and RV-4 relays release.

From this point, the terminating sender and incoming trunk are disconnected as described under telltale, with the exception that the release of the P-4 and P-6 relays are omitted. As described under telltale, the overstep results in an overflow, if a panel office is involved, or in a second trial if a crossbar office originated the call.

TROUBLE RELEASE BY THE TERMINATING MARKER

If the terminating marker involved on a call encounters trouble it sends a trouble release signal, which causes the connector to summon a different marker for the second trial. The terminating sender is unaware of this substitution. However, if the second marker encounters trouble it grounds the TRL lead, causing the following.

The TRL relay operating disconnects battery from the ST lead to the term marker connector releasing the terminating marker connector OS 501.

Off-normal ground at the RL relay is removed from the S lead to the sender link and the locking circuit of the ON-1 relay is opened in parallel.

This is ineffective at this time, as the connector circuit maintains a ground on the HLD lead (replacing the above-mentioned ground) until it disconnects.

Terminating sender circuit ON-1 relay and the operated PH and SH hold magnets of the sender link release in parallel.

> The terminating marker connector circuit in disconnecting removes ground from the HLD lead causing the above functions to occur. From this point, disconnection occurs as described for a regular call, with the exception that the TRL relay is released at the same point and in place of the RL relay.
>
> On a trouble release, the incoming trunk is connected through to the originating office with its A and D relays operated. The trunk circuit F relay may or may not have been operated by the marker and the RC relay may be normal or operated, depending upon the point at which the marker encountered the trouble. Therefore, if the RC relay is normal, the calling subscriber is connected through to the incoming trunk and receives no audible ring, busy back or overflow signal. If the RC relay of the trunk is operated, the calling subscriber will receive an audible ring signal even though no connection has been established.

PREMATURE DISCONNECTION

If the calling subscriber disconnects during selections, the terminating sender and incoming trunk are disconnected as described in telltale. This is due to the originating sender causing the terminating sender to register a telltale. However, if the calling subscriber disconnects after trunk closure, but before the marker sends a release signal, the terminating sender must be disconnected from the trunk at once. This is necessary as the trunk may be seized for another call, and must be clear of the terminating sender in order to seize a new terminating sender.

In this case the incoming trunk circuit A and D relays are operated and the terminating sender has advanced (as in a regular call) to the point at which the TC-1 and TC-2 relays are operated. When the disconnection takes place the following occurs.

Incoming trunk circuit A relay releases.

Incoming trunk circuit D relay and terminating sender circuit TC-1 relay release.

> The release of the incoming trunk A relay removes the locking ground of the D relay and disconnects ground from the D lead to the terminating sender, releasing the sender TC-1 relay.

Terminating sender circuit TC-3 relay operates.

> The TC-3 relay is slow operate to prevent its operation on a momentary or accidental break in the fundamental circuit.

Terminating sender circuit RL relay operates and locks.

From this point the terminating sender circuit disconnects as described for a regular call. The TC-3 relay releases after the TC-2 releases. If the calling subscriber were to disconnect after the marker sent a release signal, disconnection would occur as described for a regular completed call.

If a call is abandoned after the fundamental circuit has been closed (for a zero selection only) long enough to operate the L, L-1 and L-2 relays and release the SM relay, but before any pulses have been sent, the opening of the fundamental at the originating end will release the L, L-1 and L-2 relays. Since no pulse has been sent, the reclosure of the fundamental for registering a telltale condition will reoperate the L relay, but the L-1 relay can not operate because the SM relay is released. With the L relay operated and the SM relay released, the IF interrupter is grounded causing the terminating sender to advance.

STUCK SENDER TIME OUT
MIN. 28 SEC. TO MAX. 58 SEC.

Various conditions may cause the terminating sender to stick and time out, among them the following: The sender is seized by a trunk having the tip or both conductors grounded; the calling subscriber does not finish dialing or else is so slow that he is still dialing after the sender times out; a trouble in the originating sender prevents the closure of the fundamental for one of the selections; a trouble in the terminator sender prevents its sending pulses.

The timing interrupter TS is always in operation on a 30 second cycle, both contacts open for approximately 28 seconds, then the back contact closing for .8 second, opening for .2 second, and then the front contact closing for one second. This cycle repeats. When the terminating sender ON-2 relay operates it grounds the armature of the TS interrupter, causing the following.

Terminating sender circuit TM-1 relay operates and locks.

When the F contact of the TS interrupter closes.

Terminating sender circuit TM-2 relay operates and locks.

When the B contact of the TS interrupter closes ground is connected to the AL lead to the miscellaneous circuit for terminating trouble indicator.

The ground connected to the AL lead results in an audible alarm.

Ground is connected to the TL to the miscellaneous circuit for terminating trouble indicator.

Ground connected to the TL lead lights the TL lamp located on the trouble indicator frame, one lamp being provided for each terminating sender circuit.

Terminating sender circuit TT relay operates and locks.

Terminating sender circuit RV-1 relay operates and locks.

> The TM-2 relay in operating bridges the top No. 9 and No. 10 contacts of the L-2 relay. These two contacts control the operation of the RV-1 relay and by short-circuiting them, the incoming advance feature can be run through whether or not the L relays are operated. From the operation of the RV-1 relay the terminating sender proceeds as described for a telltale minus the operation of the RL relay, thereby causing a complete or partial release of the terminating sender, this depending upon the conditions at the originating end.
>
> If the nature of the trouble is such that the terminating sender fails to restore, an additional period of one second is allowed and then the following occurs:

Terminating sender circuit TRL relay operates and locks.

> When the F contact of the TS interrupter closes with the TM-2 relay operated.
>
> With the TRL relay operated an attempt is now made to restore the terminating sender as described under trouble release. If for any reason the sender should fail to restore, such as a plug in the hold jack which prevents the release of the TRL relay, it remains stuck, the TL lamp remains lighted and the AL lead to the trouble indicator remains grounded continuing the audible alarm.

HOLD JACK

There is a hold jack for each terminating sender located on the terminating trouble indicator frame. A make-busy plug is inserted in the hold jack when it is desired to hold the sender for examination after any time out or trouble release.

If there is no plug in the hold jack the sender restores to normal in most cases. However, if there is a make-busy plug in the jack, anything that causes the TRL relay to operate and lock results in the ON-1 relay being held operated by its secondary winding. The holding of the ON-1 relay prevents disconnection from occurring, thereby causing the registers and all locked relays to hold, and the sender to continue to test busy with its SB lead grounded until it is restored by withdrawing the plug from the hold jack.

FALSELY GROUNDED S LEAD

If, after the terminating sender has started on a call, the S lead from the sender link becomes falsely grounded, due to a trouble, the sender will complete the call in the usual manner. However, disconnection can not occur as the false ground on the S lead will lock the ON-1 relay.

This results in the timing circuit functioning in an effort to clear the sender. This, however, is ineffective and the sender remains stuck, until the false ground is removed from the S lead.

TEST FRAME AT INCOMING ADVANCE

When the sender test frame checks for the nonoperate of the terminating sender L relays, the L relay remains normal. At this time the sender is returning normal battery and ground to the test frame. Consequently a polarized relay of the test circuit does not operate and as the test circuit has placed a nonoperate condition on the L relay, it fails to operate. This prevents reverse battery from being sent to the test frame and the test is blocked. To advance the sender at this time requires the use of the IF interrupter, as described in the following.

IF INTERRUPTER
MIN. .98 SEC. - MAX. 2.28 SEC.

Several other conditions can be paralleled with the above, in the use of the IF interrupter. As already described the IF interrupter is grounded anytime the TT relay operates. It is also grounded when the FU hold magnet operates or should the L relay be operated with the SM relay released.

Should the terminating sender be delayed under any of the above conditions, the following takes place.

Terminating sender circuit IF relay operates and locks when the B contact of the IF interrupter closes.

Terminating sender circuit IF-1 relay operates and locks when the F contact of the IF interrupter closes.

Terminating sender circuit RV-1 relay operates and locks.

> The terminating sender and originating sender or test frame are advanced from this point when the RV-1 relay operates. Soak of the L relay is omitted under these conditions by the operation of the IF-1 relay. On a regular call the operation of the RV-1 relay opens the operating circuit for the IF-1 relay.

SENDER SEIZED AND HELD FOR TEST

All the individual and common leads from the terminating sender and the subgroup of ten senders which connect to the sender link and controller circuit also connect to the sender test circuit, except the individual leads SB, BS and SC.

The test frame seizes a sender for test in the same way that the sender link and controller circuit seizes it for service, except that it demands a particular sender instead of choosing one more or less at random. Before it can seize the desired sender, the latter must be idle, and to determine this it makes a test of the S lead, which is not made in the case of a service connection.

If a sender is engaged on a call the S lead is grounded by the ON-2 relay being operated. If the sender is made busy, the S lead is connected to a resistance battery from the MB relay.

The test frame first tests the S lead for battery and then for ground. Finding neither, it connects to the sender; otherwise it waits until the battery or ground is removed.

When the test frame seizes the sender, it functions for a regular service call.

TERMINATING SENDER MADE BUSY FOR MAINTENANCE

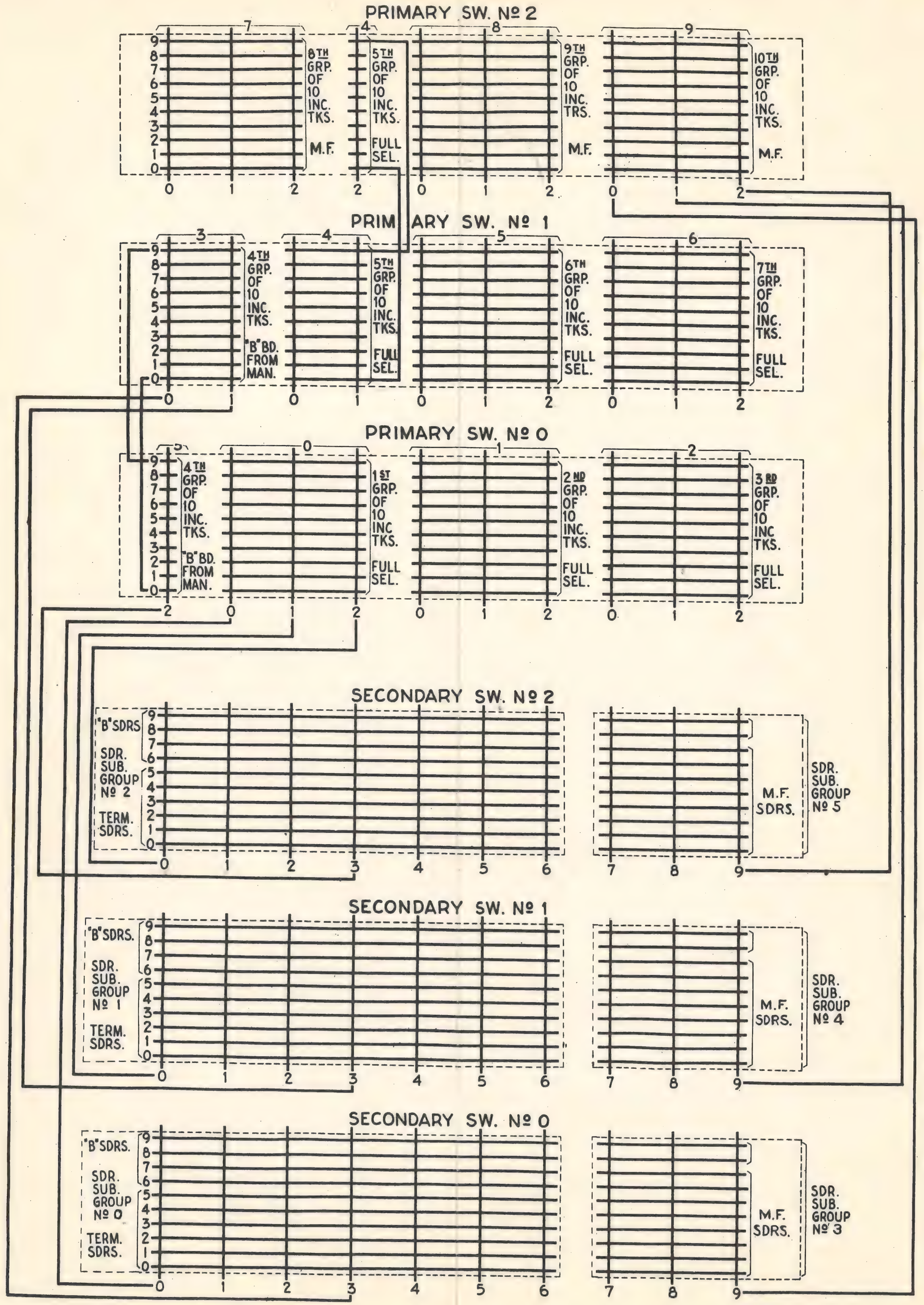
The terminating sender is made busy when it is in trouble or for other purposes of maintenance by inserting a make-busy plug in the make-busy jack. There is one such jack for each sender, located on the trouble indicator frame. Insertion of a plug in the make-busy jack operates the MB relay if provided, otherwise it grounds the SB lead direct, to indicate that the sender is busy. The MB relay, if provided, grounds the SB lead and also connects resistance battery to the S lead to serve as a busy signal to the sender test frame.

If a terminating marker connector serving five senders is made busy, by means of a busy plug, each of the five senders is made busy by the grounding of its MB lead from the connector circuit. This has the same effect on each sender as the insertion of a plug in the make-busy jack.

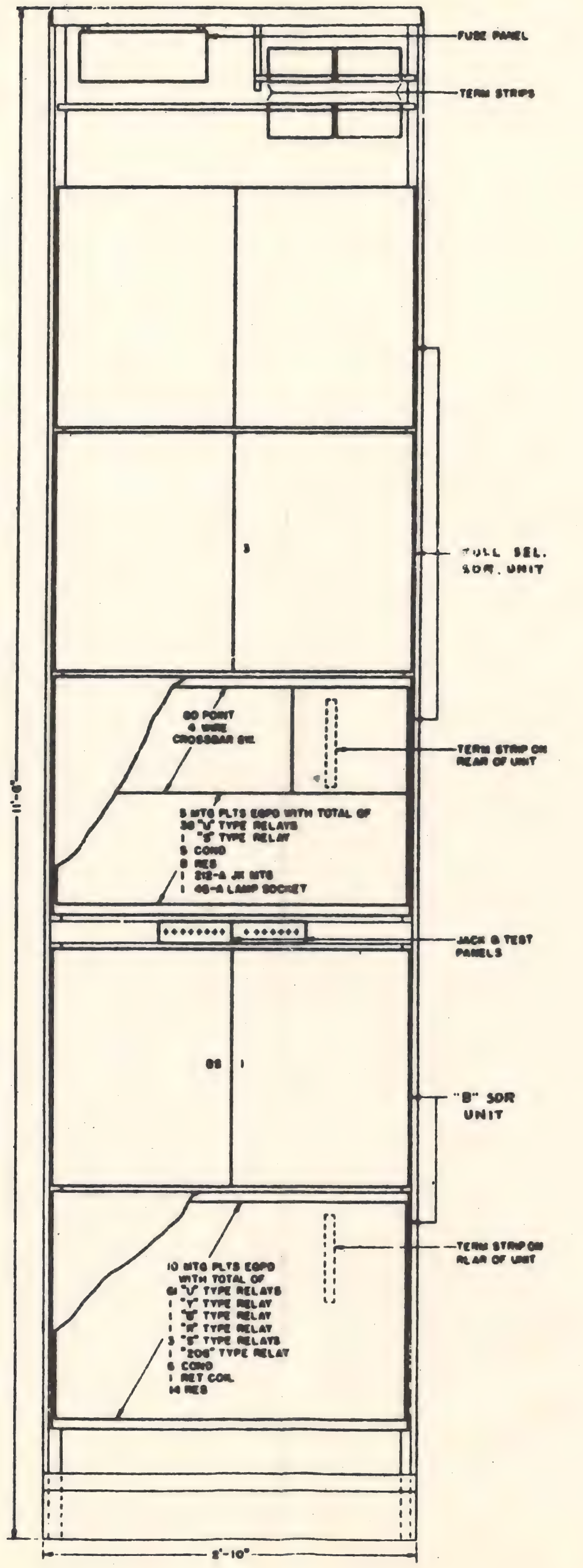
The grounding of the SB lead when the terminating sender is made busy operates the SB relay in the sender subgroup circuit which in turn grounds the BS lead to the terminating sender. In order to prevent the ON-2 relay from operating before the ON-1 relay operates or from holding if the sender is made busy while engaged on a call, the BS lead is carried through make contacts of the ON-1 and RA-1 relays. Therefore, the ON-2 relay can not operate until the ON-1 relay has operated and the release of the ON-1 relay always effects the release of the ON-2 relay.

"T" JACK

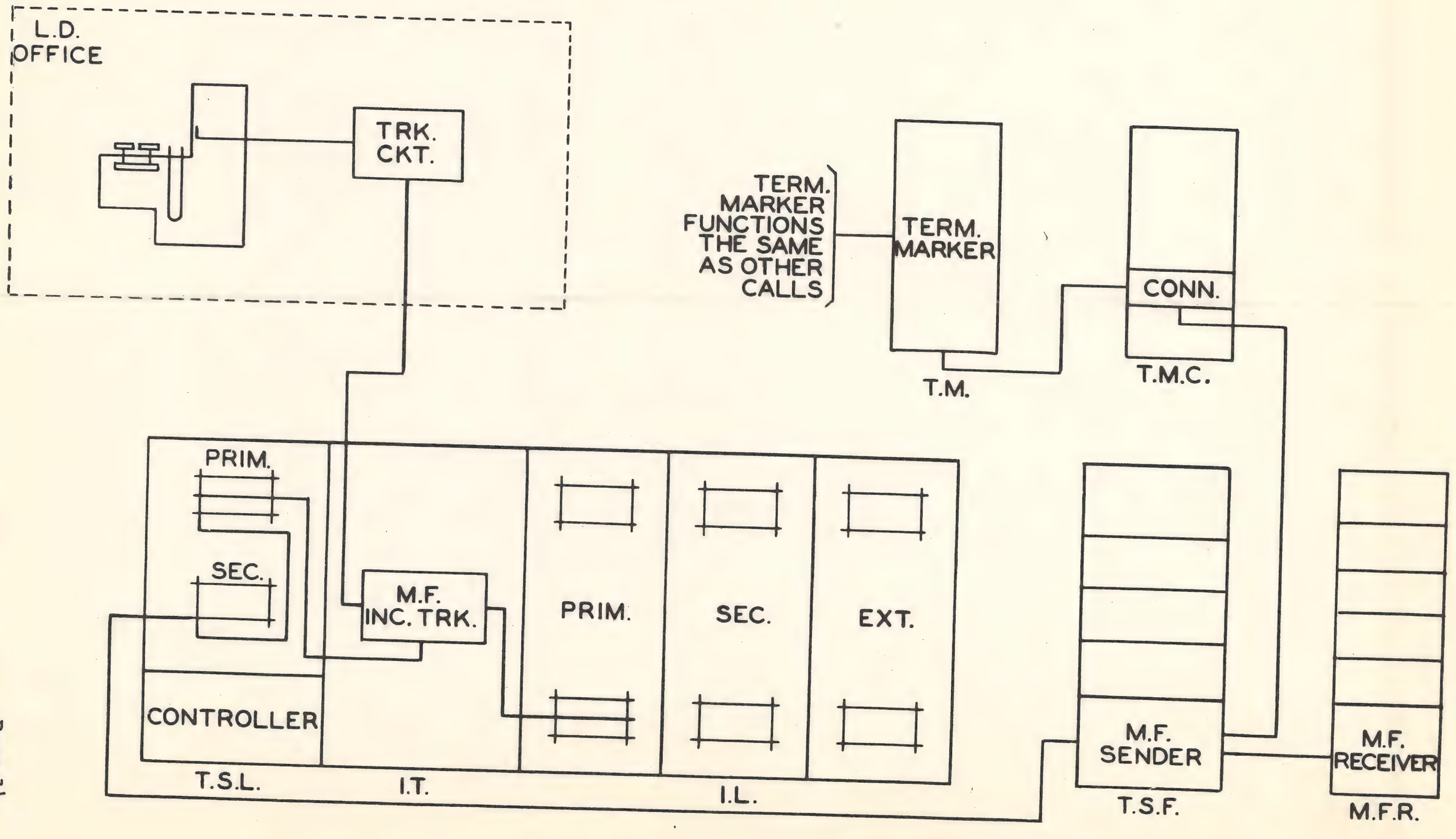
The T jack of the terminating sender provides a means of connecting a special test set known as a "per cent break meter and pulse counter." This test set provides means of checking the characteristics of the pulses generated by the terminating senders.


PRIMARY SW. Nº 2
8TH GRP. OF 10 INC. TKS. M.F.
5TH GRP. OF 10 INC. TKS. FULL SEL.
9TH GRP. OF 10 INC. TRS. M.F.
10TH GRP. OF 10 INC. TKS. M.F.
PRIMARY SW. Nº 1
4TH GRP. OF 10 INC. TKS. "B" BD. FROM MAN.
5TH GRP. OF 10 INC. TKS. FULL SEL.
6TH GRP. OF 10 INC. TKS. FULL SEL.
7TH GRP. OF 10 INC. TKS. FULL SEL.
PRIMARY SW. Nº 0
4TH GRP. OF 10 INC. TKS. "B" BD. FROM MAN.
1ST GRP. OF 10 INC TKS. FULL SEL.
2ND GRP. OF 10 INC. TKS. FULL SEL.
3RD GRP. OF 10 INC TKS. FULL SEL.
SECONDARY SW. Nº 2
"B" SDRS
SDR. SUB. GROUP Nº 2
TERM. SDRS.
M.F. SDRS.
SDR. SUB. GROUP Nº 5
SECONDARY SW. Nº 1
"B" SDRS.
SDR. SUB. GROUP Nº 1
TERM. SDRS.
M.F. SDRS.
SDR. SUB. GROUP Nº 4
SECONDARY SW. Nº 0
"B" SDRS.
SDR. SUB. GROUP Nº 0
TERM. SDRS.
M.F. SDRS.
SDR. SUB. GROUP Nº 3

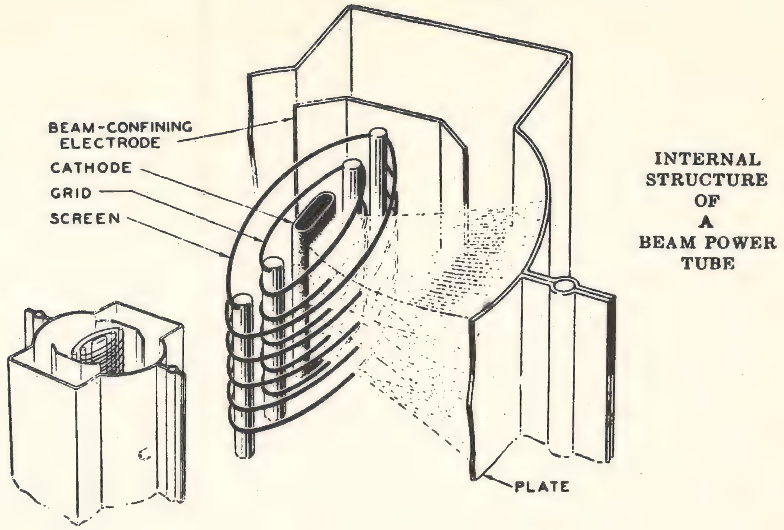
LINKAGE ON TERMINATING SENDER LINK FRAME



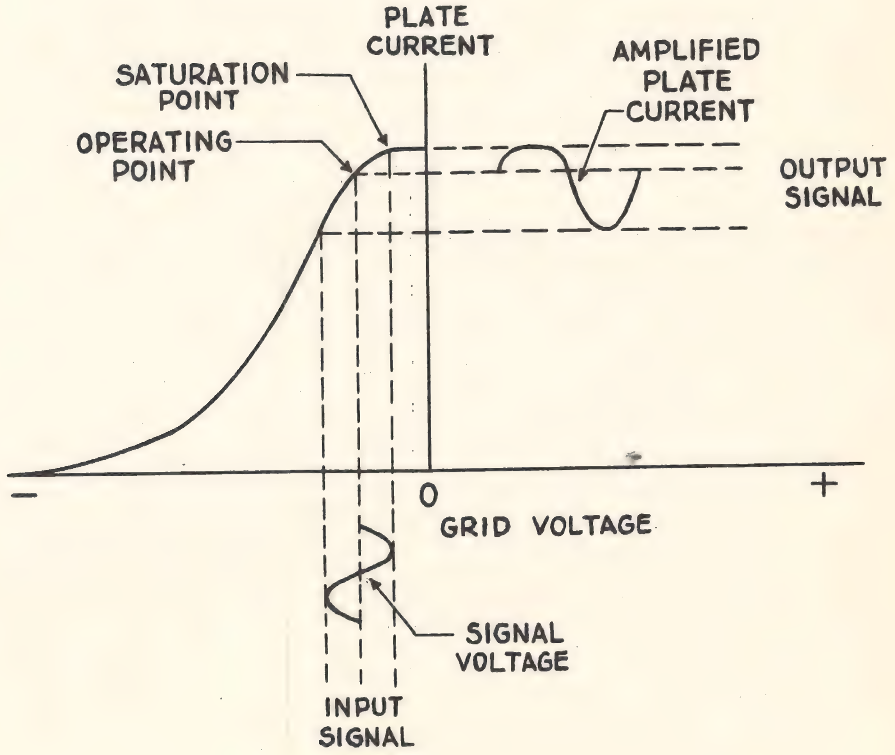
TERMINATING SENDER FRAME



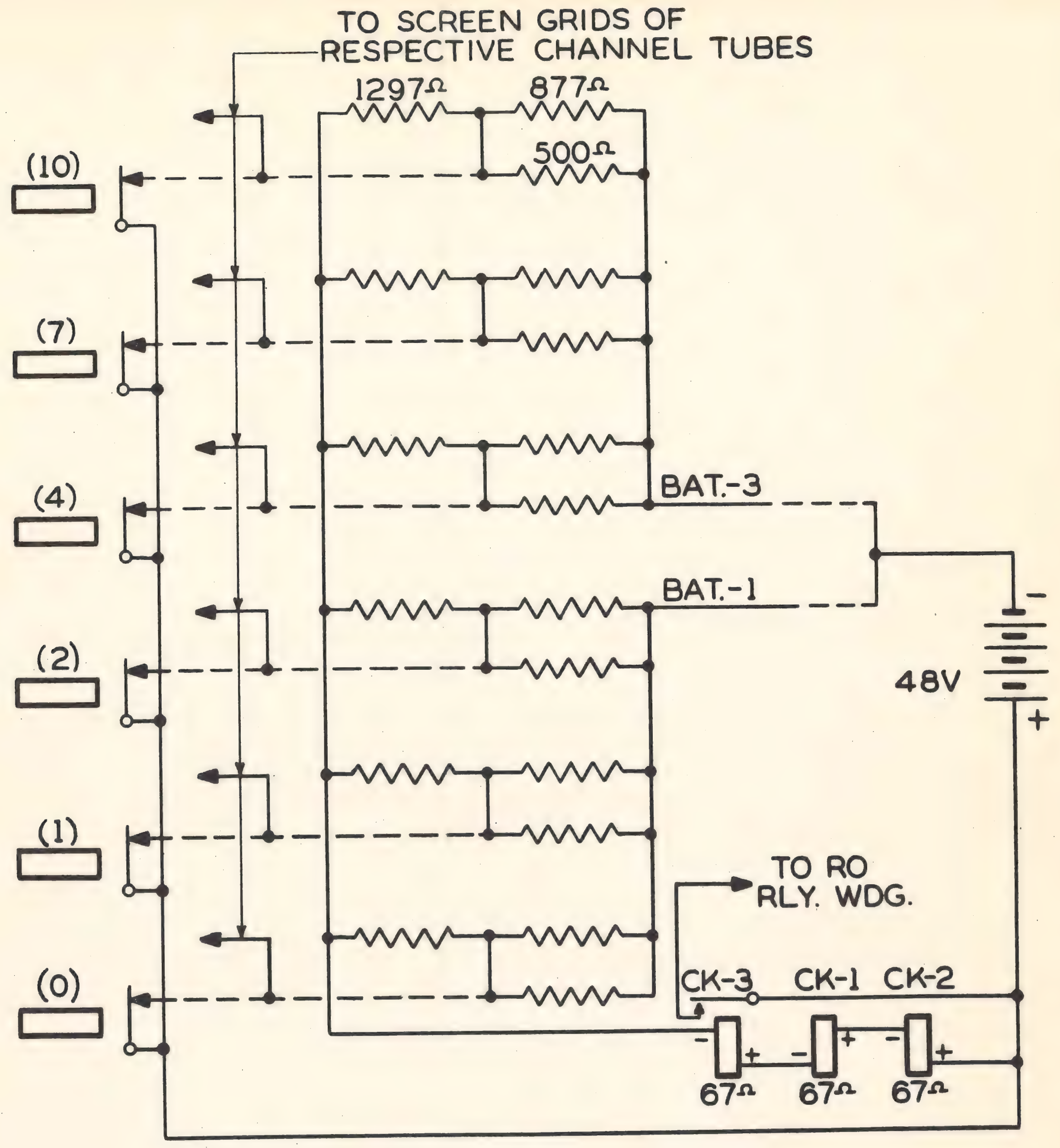
SCHEMATIC OF MF CALL



375A VACUUM TUBE
BEAM POWER AMPLIFIER



OPERATING CHARACTERISTICS
OF
375A VACUUM TUBE



FREQUENCIES RECEIVED	CK RELAYS OPERATE	SENDER ACTION
1	NONE	CAN'T LOCK DIGIT RECEIVED OR ADVANCE TO RECORD NEXT DIGIT.
2	1 & 2	LOCKS DIGIT RECEIVED AND ADVANCES TO RECORD NEXT DIGIT.
3 OR MORE	1,2 & 3	CK-3 OPERATES RO RELAY, SENDER CALLS MARKER AND IS RELEASED.

POTENTIOMETER CIRCUIT
FOR CHECKING
NUMBER OF FREQUENCIES

CHAPTER 6

SECTION 6

METHOD OF OPERATION

Multi-Frequency Sender Circuit	SD-25455-01
Multi-Frequency Receiver Circuit	SD-95087-01
Incoming Trunk Circuit	SD-25302-01
Timing Circuit for Incoming Trunk Circuit	SD-25038-01

MARCH 1954

Complete OS and SC's for the Multi-Frequency Terminating Sender will be available at a later date. The following written material is presented on a temporary basis to be used with OS 416-2 sheets 1 and 2 and the SD Drawings.

METHOD OF OPERATION

PURPOSE

The incoming trunk circuit used in conjunction with the terminating sender link circuit and the terminating marker circuit, sets up the proper ringing, supervisory and transmission conditions. It can be arranged through optional wiring for an on-hook or off-hook supervision to the originating end.

The terminating sender link and controller circuit provides a crossbar switch link arrangement for connecting this type of trunk to only an idle terminating multi-frequency sender circuit.

The terminating multi-frequency sender circuit and its associated mulit-frequency receiving circuit, is used to permit a toll operator or an MF out pulsing sender to establish a connection to a subscriber in a crossbar office. The desired number is registered directly in the sender from the MF pulsing receiving circuit. Upon completion of registration, a terminating marker is summoned which then completer the connection from the incoming trunk to the called subscriber's line.

The multi-frequency pulsing circuit is permanently connected with a terminating multi-frequency sender and is used to receive signals in the form of pulses of voice frequency current from a keyset or sender and to convert the signals into direct current pulses to operate various code combinations of relays in the associated sender circuit.

DESCRIPTION

Terminating Sender Frame

The terminating multi-frequency senders can be mounted on the same days, with the full selector senders or "B" senders, or in a bay of exclusively MF senders. There are five senders to a frame, numbered zero to four.

Multi-Frequency Receiver Frame

The multi-frequency receiver frame is a single sided bay mounting six receiving units and designated MFR, and numbering from zero up in the office. The receiving circuits on a frame are designated zero to five.

Each receiving unit is connected to its associated terminating MF sender by 19 leads. Each sender unit is connected to its associated terminating marker connector by 33 leads.

FUNCTIONS

Preparation of Receiving Circuit RM 6-4

There are nine pentode vacuum tubes in a receiving circuit. A penthode vacuum tube is a five element tube, not counting the heater. There are six connections to a tube, numbered 2 to 8. The following is the association of the elements in the pentode tube, with the connection numbering:

	Plate	#3
Five	Suppressor Grid	(Connected to cathode)
Elements	Screen Grid	#4
	Control Grid	#5
	Cathode	#8
	Heater	#2 & #7

The heater of the L1 and L2 tubes are wired in series and in paralled with the heaters of the 0 and 1 tube which are in series. These tubes use A negative battery at the BCO jack, to A positive ground through the H1, H2, and H3 resistances, in series.

The heater of the 7 and 10 tubes are wired in series and in parallel with the heaters of the 2 and 4 tube which are in series. These tubes use B negative battery at the BCO jack, to A positive ground through the H4, H5, and H6 resistances, in series.

The heater of the SP tube uses the C negative battery at the BCO jack to positive ground through H7, H8, and H9 resistances, in series.

The vacuum tubes must be energized for the receiving circuit to be operative. They will normally be left on continuously, except when the circuit is taken out of service.

Seizure of Incoming Trunk

When this incoming trunk circuit is normal it has the A relay connected with battery on the tip and ground on the ring toward the distant originating offices. This trunk will be associated with either an out trunk in the toll switching system No. 4 or a jack ended trunk at a toll switchboard.

When the incoming trunk is seized by either the No. 4 toll system or a toll operator for a multi-frequency termination, a polarized supervisory relay is connected across the tip and ring, causing the following:

Incoming trunk circuit A relay operates.

> Ground is connected to the ST lead to the terminating sender link and controller circuit.

Ground connected to the ST lead causes the terminating sender link and controller circuit to function, except that it will require the services of a multi-frequency sender for the call.

The incoming trunks for these two types of terminating calls will be included in the same trunk group and must appear in the primary switches of the terminating sender link frame, so that the links have access to multi-frequency senders.

Sender Seizure and Registration of Frame Indication

When the controller circuit has progressed to the selection of an idle multi-frequency sender, by the operation of an S relay, ground is connected to the SC lead causing the following to take place in the selected sender:

Terminating sender circuit SC-1 relay operates.

From ground on the SC lead coming from the break contacts of either the GAT or GBT relay.

Terminating sender circuit SPL relay operates.

From ground on the FC lead of special incoming trunk circuits.

If an incoming trunk circuit requires the use of a special marker it connects ground to its FC lead.

Ground is connected to the SPL lead to the terminating marker connector.

Terminating sender circuit F00 or F10 relay operates.

From ground connected to the correspondingly numbered F00 or F10 lead at the terminating sender link C or TG relay, whichever is required.

If the incoming trunk appears on one of the incoming link frames whose number is in the group 0 to 9, the F00 relay is operated. If it is in the group 10 to 19, the F10 relay is operated.

Ground is connected to the F10 lead to the terminating marker connector if the F10 relay operates.

The CK4 lead is connected to the F10 lead to the terminating marker connector if the F00 relay operates.

Terminating sender circuit FT relay operates.

Terminating sender circuir OA or OB relay operates.

From ground on the OA or OB lead and furnished at the TG- relay when office "unit" information is required.

Ground is connected to the OAB lead to the terminating marker connected if the OB relay operates.

Terminating sender circuit SC-2 relay operates.

Terminating sender circuit F - relay operates.

From ground on one of the F0 to F9 leads.

There are ten F - relays, numbered 0 to 9. The one to operate corresponds in number to one of the F0 to F9 leads that is grounded by the terminating sender link C or TG relay, whichever is required.

Ground is connected to leads F1, F2, F4, and F5 according to the incoming link frame required for this call.

Frame	Leads	Frame	Leads
0 or 10	None	5 or 15	F5
1 or 11	F1	6 or 16	F1 and F5
2 or 12	F2	7 or 17	F2 and F5
3 or 13	F1 and F2	8 or 18	F1, F2 and F5
4 or 14	F4	9 or 19	F4 and F5

Sender Off-Normal Control

After the controller has grounded the SC lead to the sender, it proceeds to make its sleeve continuity test and the double connection test. Upon completion of a satisfactory double connection test, the controller connects ground to the GS lead of the sender, causing the following.

Terminating sender circuit ON1 relay operates.

From ground on the GS lead.

Ground is connected to the SB lead to the terminating sender link and controller circuit.

The ground connected to the SB lead causes the associated SB relay to operate in the sender subgroup circuit, making the sender busy to other calls.

The OA or OB relay locks, if operated.

The operated F - relay locks.

The operated F00 or F10 relay locks.

The SPL relay locks, if operated.

Ground is connected to the SB punching for the holding time recorder.

Battery is connected to the BAT-1 lead to the receiving circuit.

Terminating sender circuit RV relay is released, if operated.

The RV relay is an nonbiased polarized relay its windings being connected differentially. Ground is connected to the primary and secondary windings by the operation of the ON1 relay. When both windings are energized, the energy in the secondary winding overpowers the energy in the primary winding, thereby insuring that the relay has its back contact closed. The polarity of the secondary winding is in the released direction.

Terminating sender circuit TM1 relay operates and locks.

If the F contact of the TM interrupter is closed.

Sender Prepared for Registration

Terminating sender circuit TRB and TR-2 relays operate in series.

The TRB relay locks and the TR-2 relay holds.

The receiving circuit 0, 1, 2, 4 and 7 leads are connected to the TH-0, TH-1,TH-2, TH-4 and TH-7 relays, respectively. (TR-2)

Terminating sender circuit TRC and TR-3 relays operate in series.

The TRC relay locks and the TR-3 relay holds.

Terminating sender circuit TRD and TR-4 relays operate in series.

The TRD relay locks and the TR-4 relay holds.

Terminating sender circuit TRE and CI relays operate in series.

The TRE relay locks and the CI relay holds.

Sender Made Busy

Before dismissing the terminating sender link controller it is necessary to make the sender busy to other calls and lock in the selected link hold magnets under control of the sender.

When the ON1 relay connects ground to the SB lead, the associated SB relay in the sender subgroup circuit operates and causes a ground to be returned on the BS lead.

Terminating sender circuit ON2 relay operates.

From ground on the BS lead and provided the required F - relay has been operated.

The FT relay locks.

A holding circuit is connected to the ON1 relay.

Ground is connected to the S lead to the terminating sender link.

The ground connected to the S lead, locks in the primary and secondary hold magnets associated with the selected link.

Battery is connected to the BAT-2 and BAT-3 leads to the receiving circuit.

The battery on the BAT-3 and BAT-1 leads connects to the network of resistances 0B, 1B, 2B, 4B, 7B, and 10B in the receiving circuit.

Central Office Battery and Ground

At this point, it should serve well to remind those who are starting contact with the receiving circuit that the central office battery is grounded on the positive side. This is pointed out for the purpose of appreciating the terminology of positive bias and negative bias, which shall be used from here on in describing the receiving circuit, that it means central office ground and central office battery, respectively. That the positive bias requires the use of the ground convention and that negative bias requires the use of the battery convention. It may also be expressed as positive potential or negative potential.

Receiving circuit CK-3 relay, in parallel with the CK-1 and CK-2 relays in series, are energized by their secondary windings. RM 6-5

From battery on the BAT-2 lead.

The CK-1, CK-2 and CK-3 relays are biased polarized relays. The energizing current in the secondary windings of these relays is in the release direction.

The primary windings of these relays are connected in series to ground at the T3 jack and to the network resistances 0B, 1B, 2B, 4B, 7B and 10B, receiving battery from the BAT-1 and BAT-3 leads. These windings are energized in the operate direction, but since the energy in the secondary windings overpower the primary windings, the relays are held on their back contacts.

It should be noted that the battery on the BAT-1 and BAT-3 leads and the primary windings of the CK-1, CK-2 and CK-3 relays, together with the 0B and 0C to 10B and 10C resistances, form a potentiometer circuit which becomes associated with the screen grids of the vacuum tubes 0, 1, 2, 4, 7 and 10. These batteries are connected in preparation for changing the screen grid voltage when the receiving circuit is in operation.

At this stage of the call the receiving circuit is considered locked, for as long as the KP-2 and KP-3 relays are normal ground on the break contacts of these relays are holding the screen grids of vacuum tubes 0 to 10 at normal potential.

Receiving circuit KP-1 relay primary winding is energized.

From battery on the BAT-2 lead.

The KP-1 relay is a nonbiased polarized relay. With the receiving circuit in normal the secondary winding is energized from battery on the T5 jack to ground on the back contacts of both the 2 and 10 relays. It will be noted that these grounds on the 2 and 10 relays are also short-circuiting the KP-1 and KP-2 condensers. The polarity on the secondary winding is in the release direction and overpowers the effect of the primary winding, which is energized in the operate direction from battery on the BAT-2 lead.

Terminating sender circuit TO relay tertiary winding is energized.

The TO relay is a nonbiased polarized relay. The energizing of the tertiary winding is to insure that the relay is on its back contact.

Release of Terminating Sender Link Controller

When the ON2 relay operated ground was connected to the RL lead causing the terminating sender link controller to release. When the sender subgroup circuit S - relay releases ground is removed from the SC lead.

Terminating sender circuit SC1 and SC2 relays release.

Due to ground being removed from SC lead.

Terminating sender circuit BC relay operates.

Ground is connected to the CO lead, through the selected link, to the incoming trunk.

The connection of ground to the CO lead of the incoming trunk causes the T relay to operate.

Terminating sender circuit A relay operates.

The battery and ground on the A relay is connected in series with the IN repeat coil in the receiving circuit, to the tip and ring of the incoming trunk. This battery and ground will match with that on the A relay in the incoming trunk, which at this time is battery tip and ground ring. It should also be noted that at the instant in which the sender A relay is operating the incoming trunk T relay is operating to remove the incoming trunk A relay from the tip and ring. This change over results in no change at the originating office.

Terminating sender circuit CKA relay operates.

Terminating sender circuit TF relay starts to release.

Terminating sender circuit A1 relay operates and locks.

Locking circuit is reestablished to the FT relay.

When the BC relay operated it caused the FT relay to start to release, but when the A1 relay operates it connects a holding circuit preventing the FT relay from releasing. This feature is to insure that the continuity of the tip and ring from the trunk to the sender, to the receiving circuit is complete and that the A relay has operated.

Terminating sender circuit RV relay operates.

The RV relay is made slow operate by condenser timing, in order to allow sufficient time for the incoming trunk A relay to be disconnected from the tip and ring, in order that the control of the call be in the terminating sender.

When the ON1 relay operated it caused the primary and secondary windings of the RV relay to be energized (Operation No. 10). The primary is the operate winding and the secondary the release winding. By the operation of the A1 relay, direct ground is disconnected from the secondary winding at the same time the short-circuit is removed from the RV condenser. Battery through the secondary winding then charges the condenser, this charging current holding the relay normal. As the condenser becomes charged, this current decreases until the energy in the primary is greater than the secondary, thus causing the relay to operate.

Start Pulsing Signal

From the beginning of the call, when the incoming trunk A relay was operated, until this point is reached in its operation, the originating office has been waiting for a signal to start pulsing. This signal is reversed battery, that is, battery on the ring and ground on the tip.

With the tip and ring of the incoming trunk now cut through to the terminating sender and the receiving circuit ready, the terminating sender circuit SP relay operates.

Battery and ground on the tip and ring, respectively, are reversed.

The primary and secondary windings of the sender A relay which are connected to the tip (T1) and ring (R1), respectively, are transferred to the ring and tip, causing the battery and ground to be reversed to the originating office.

Terminating sender circuit RT relay operates.

Multifrequencies

This type of call from an originating toll office to a No. 1 crossbar office, is on a multifrequency basis. This consists of transmitting two frequencies of various combinations for each digit required. Five digits are required for any complete termination, one digit known as the KP signal and the four numerical digits of the called number.

The multifrequency signals may be sent out by an operator using a keyset which connects the proper frequencies for each digit to the trunk or by another sender. The two frequencies for each digit are received instantaneously. The multifrequencies are ac voltages, superimposed onto the tip and ring dc circuit, which is being supplied by the battery and ground on the terminating sender A relay.

The signalling frequencies used for the multifrequency pulsing are 700, 900, 1100, 1300, 1500 and 1700 cycles, which have been designated 0, 1, 2, 4, 7 and 10 respectively. Frequencies 0 to 7 are used for digit codes and frequency 10 is used in combination with frequency 2 for the KP signal. The following chart indicates the combinations used.

Frequency & Designation		DITIT CODES											
		0	1	2	3	4	5	6	7	8	9	KP	ST
1700	(10)											X	X
1500	(7)	X							X	X	X		X
1300	(4)	X				X	X	X					
1100	(2)			X	X			X			X	X	
900	(1)		X		X		X			X			
700	(0)		X	X		X			X				

X Frequency Used.

It will be noted from the above chart that the additive system is used for determining the two frequencies required for all digits except zero and the KP signal. For digits 1 to 9 the two frequency designations are added together, by using the smallest combination for the addition. For digit zero and the KP signal they add up to 11 and 12.

KP Signal Frequencies On

When the receiving circuit IN repeat coil is cut through to a trunk or a keyset circuit at the beginning of a call, there is a brief period during which it may be exposed to speech or noise currents, which, if it were necessary to receive digit pulses, might cause false registrations in the associated sender circuit. To prevent this, the receiving circuit is normally held in a condition wherein digits can not be registered until after it has been unlocked by the functioning of the KP signal. This signal is composed of a relatively long period of frequencies 2 and 10, which must be on for the required time without presence of the other frequencies 0, 1, 4 and 7.

When the sender SP relay operates and reverses the battery and ground, this is the signal to the No. 4 toll equipment or the toll switchboard operator to start pulsing the frequencies. When the KP digit frequencies are present in the primary coils of the IN repeat coil, they are induced into the secondary coils.

Receiving circuit L1 and L2 limiter tubes function to amplify and limit the KP signal to the 0, 1, 2, 4, 7, 10 and IN filters.

> The L1 and L2 vacuum tubes are arranged for push-pull amplication, the 54W retardation coil being used as an autotransformer. In push-pull amplication each tube works on one half of the ac cycle, the other tube at that instant being cutoff.
>
> The KP signal is filtered through the 2 and 10 filters to the control grids of channel tubes 2 and 10.
>
> The compensating filter CF is provided to improve the characteristics of the 700 and the 1700 cycle filters by simulating the the effect which would be produced by adjacent filters below and above them, respectively.
>
> The KP signal is filtered through the IN filter to the SP input transformer.

Receiving circuit 2 and 10 channel tubes function and reduce their plate current.

> Current in the secondary windings of the receiving circuit 2 and 10 relays is reduced.
>
> The channel vacuum tubes are operated as detectors, which convert the ac signal into rectified dc in their plate circuits. Each plate circuit is connected through the bias winding of its associated polarized relay and the action is such that when signals are present, the plate currents in the tubes of the channels involved are reduced, thereby, reducing the current in the secondary or bias windings.

Signal Present Circuit

The KP signal as amplified by the L1 and L2 tubes, enters the L condenser and network resistances N1, N2, N3, N4 and N5. This output of the limiter circuit is divided into two parts by the resistances N1 and N2. The voltage across the N2 resistance is delivered through the network N3 and N4 resistances to the six channel circuits, while the voltage across the N1 resistance is applied through resistance N5 and the IN filter to the primary coil of the SP input transformer. The induced voltage into the secondary coil of the SP input transformer, causes the following.

Receiving circuit SP tube functions and reduces the plate current.

> Due to the induction in the SP input transformer because of a signal present.

The signal present circuit is ahead of the channel filter circuits for the purpose of indicating to the receiver when there is a signal present of sufficient magnitude and is to be locked in. The purpose of the SP circuit is to prevent duplicate registration of a digit when the incoming signal is prolonged.

Receiving circuit SP relay operates.

Due to the reduction of current in its secondary winding caused by the action of the plate current of the SP tube.

With no signal present, both windings of the SP relay are energized. The primary winding is energized from ground on the T1 jack to battery on the FLT repeat coil. The secondary winding receives its supply from ground on the T1 jack to the plate of the SP tube. Since the primary winding is poles for operate and the secondary winding is poled for release, the secondary overpowers the primary until the current is reduced on the plate of the SP tube.

The purpose of the SP retardation coil and the SP1 condenser, is to reduce modulation products which would otherwise cause the SP relay to chatter. It also slows up the operate and release time of the relay, by the charge and discharge of the SP1 condenser.

The cathode bias on the L1, L2 and SP tubes is made more negative and the short-circuit is removed from the L3 condenser.

With the SP relay normal the back contact is connecting a positive potential in parallel with a negative potential, to the cathodes of the L1, L2 and SP tubes the bias being more negative than positive, and by this same circuit the L2 condenser is short circuited. This holds the tubes to a definite limited output.

When the SP relay operates and removes this positive potential, the short-circuit is removed from the L3 condenser at the same time, which charges and continues to hold a positive bias in the parallel circuit on the cathodes. When the L3 condenser is charged to the potential of the battery on the FLT repeat coil there will be no further current flow in this leg of the circuit. When this point is reached, the cathode bias on the L1, L2 and SP tubes becomes more negative, thus increasing their sensitivity. This will cause a rise in the volume limiter circuit which will be sufficiently gradual, by the L3 condenser charging to prevent objectionable transients.

Receiving circuit 2 and 10 relays operate in series.

Because the current in the secondary windings is reduced at this moment.

The operation of the SP relay connects ground to the primary windings of the 0, 1, 2, 4, 7 and 10 relays, in series, but only the 2 and 10 relay can operate because of the reduction of current in their secondary windings. The primary windings in series, are poled in the operate direction. The circuit is traced from filtered battery on the FLT repeat coil to the primary winding of the 10 relay, in series with the 7, 4, 2, 1 and 0 relay, through the T1 jack, CH1 resistance, over the L lead to the terminating sender, make contacts CI relay, back contacts TO relay, over J lead to receiving circuit, back contacts CK-1 relay, make contacts of SP relay to ground.

Receiving circuit KP-1 relay operates.

The KP-1 relay is made slow operate by condenser timing for the purpose of insuring that the KP signal is present for its proper duration. The condenser timing effect is the same as already described fro the RV relay (Operation No. 26), but since the capacity of condensers KP-1 and KP-2 are much smaller than the RV condenser in the sender, the time interval will be reduced in proportion.

It should be noted that on the KP signal only the 2 and 10 relays, both operated can remove the short-circuit from the KP-1 and KP-2 condensers.

As previously stated, it is necessary that frequencies 2 and 10 be received for a definite length of time without frequencies 0, 1, 4 and 7 being present if the receiver is to be unlocked. If an impulse of one or more of these frequencies should appear at the same time as the KP signal, the corresponding channel relay or relays will operate and apply a short-circuiting ground to the KP-1 and KP-2 condensers. This will take place through the back contacts of the KP-2 and KP-3 relays. This will restore the full bias current to the secondary winding of the KP-1 relay releasing it immediately and discharging the KP-1 and KP-2 condensers rapidly. This restores the condenser timing in preparation for a new timing cycle, with the net result that the receiver remains locked until frequencies 2 and 10 appear by themselves for the necessary length of time.

The KP-1 relay takes about 48 milliseconds to operate

KP Signal Frequencies Off

When the KP signal is disconnected from the fundamental circuit, the L1, L2, SP, 2 and 10 tubes all return to normal. This means that their control grid bias and plate voltage return to their normal value. This will cause the plate current in the SP, 2 and 10 tubes to increase and place the normal bias on the secondary windings of the SP, 2 and 10 relays.

Receiving circuit SP relay releases.

Receiving circuit 2 relay releases.

Receiving circuit 10 relay releases.

Receiving circuit KP-2 and KP-3 relays operate and lock, in parallel.

Due to the operation of the KP-1 relay and the release of either the 2 or 10 relay.

While the signal present circuit causes the operation of the KP-1 relay, the 2 or 10 relay must return to normal in order to have an operating circuit for the KP-2 and KP-3 relays.

A holding circuit is connected to the KP-2 relay.

A holding circuit is connected to the KP-3 relay.

The receiving circuit is unlocked.

This is accomplished by the removal of ground from the OC to 10C resistances, allowing the ground on the back contacts of the 0, 1, 4 and 7 relays to have control and the ground on the back contacts of the 2 and 10 relays to be connected to the 2C and 10C resistances.

The tertiary windings of the 0, 1, 2, 4, 7 and 10 relays are energized, in series.

The tertiary windings of the 0 to 10 relays are wired in series and are energized from the filtered battery on the FLT repeat coil to ground on the make contacts of the KP-3 relay. These windings supply a small additional bias to the 0 to 10 relays when the receiver is prepared to receive the numerical digits, but not when it is waiting for the KP signal. This bias is necessary to insure the release of relays after they have been locked up on digit codes, as described later, but is not needed when the KP signal is being received because by omitting this circuit a small increase in sensitivity is obtained.

Receiving circuit KP-1 relay releases.

Due to closure of a path through its release winding (secondary) by the operation of the KP-2 relay.

The top 4 and 5 contacts of the KP-2 relay causes the secondary winding of the KP-1 relay to be energized and the KP-1 and KP-2 condensers to be short-circuited. This causes the KP-1 relay to release and the discharge of the condensers, but it does not interfere with the unlocking of the receiver because the KP-2 and KP-3 relays have locked up. The purpose of this arrangement is to make sure that the timing circuit is normal and ready to give a complete timing cycle on the next call, without having to place any requirements on the open interval required between the calls.

A sequence adjustment is made on the contacts of the KP-2 relay, to insure that the locking circuit, the top 10 and 11 contacts make ahead of the top 4 and 5 contacts that release the KP-1 relay.

The KP-3 resistance is provided to insure that relay KP-1 shall always go to its back contact when the receiver is idle. If it were omitted the removal of battery from the BAT-2 lead during the time between the breaking of the back contact of relay KP-1 and the operation of relays KP-2 and KP-3, as might occur in an abandoned call, would leave the circuit blocked, since the condensers would be charged and there would be no current flowing in the secondary winding of relay KP-1 to release it.

The temporary locking circuit for the KP-2 relay is opened.

The temporary holding circuit for the KP-2 relay is opened.

The temporary locking circuit for the KP-3 relay is opened.

The temporary holding circuit for the KP-3 relay is opened.

Thousands Digit Frequencies On

The receiving circuit is now ready to receive the digit frequencies for the thousands, hundreds, tens and unit digits, which follow immediately after the KP signal. When the thousands digit frequencies are connected the circuit functions as already described from operation No. 29 to No. 32, including its minor operations. At this point the signal counting takes place, but only frequencies 0, 1, 2, 4 and 7 will be used in the combinations for digit counting. Each frequency finds a path through its corresponding filter to the grid of its corresponding channel tube, causing the operation of its associated channel relay. With the two required channel relays operated for the thousands digit, the two channel relays operated are locked.

Due to the action of the screen grid of their associated channel tube.

This locking action is obtained in a rather unusual way by means of the vacuum tube circuits. When a channel relay operates, after the plate current flowing through its bias winding has been reduced sufficiently by the incoming signal, it connects the screen grid of its associated tube to a potentiometer which supplies a much lower voltage than normal. This is accomplished by the removal of the grounds on the back contacts of the two channel relays to the screen grid of the associated vacuum tubes (+ voltage with respect to the cathode of the tube) and substitution of the reduced voltage obtained from the potentiometer made up of the associated resistances OB and OC to 7B and 7C, and the primary windings of the CK-1, CK-2 and CK-3 relays.

This causes the plate current on each of the two channel tubes involved to drop below 3 mills and remain there, effectively locking up their associated relays until the operate windings (primary) are deenergized. This action can not take place before the KP-2 and KP-3 relays are operated because ground is held on the screen grid of the tubes from the back contacts of these relays. This is the unlocking action of the receiver.

Registration of Thousands Digit

When the two channel relays of the group 0, 1, 2, 4 and 7 have operated for the thousands digit, two leads are ground to the terminating sender, each one being of the same designation as the relay grounding the lead.

Terminating sender cicuit TH - relays (two) operate.

> Associated TH - leads are grounded to the terminating marker connector circuit.
>
> The terminating marker connector TH - leads that are not required are connected to the CK-1 lead.

DIGITS PULSED ADDITIVE SYSTEM

	NUMERICAL DIGIT									
	0	1	2	3	4	5	6	7	8	9
TERM SENDER REG. RELS. OPTD.	4-7	0-1	0-2	1-2	0-4	1-4	2-4	0-7	1-7	2-7
THOUSANDS LEADS GROUNDED TO MKR. CONN.	None	1	2	1 2	4	1 4	2 4	1 2 4	8	1 8
OTHER DIGIT LEADS GROUNDED TO MKR. CONN.	None	1	2	1 2	4	5	1 5	2 5	1 2 5	4 5

Signal Counting

The signal counting circuit is provided for the purpose of recognizing that a correct digit signal, consisting of two frequencies and only two, is being received after the circuit has been unlocked by the KP signal, while if an extraneous frequency should appear and operate one or more additional channel relays, a reorder signal is given. Assuming that the correct signal has been received operating the two channel relays. When the locking circuit becomes effective for the two channel relays receiving circuit CK-1 and CK-2 relays operate, in series.

> The CK-3 relay does not operat in the series circuit as long as a combination of only two frequencies are received per numerical digit. Should one or more additional frequencies be received, the removal of more than two of the grounds on the back contacts of the channel relays changes the balance in the screen grid potentiometer circuit, causing the CK-3 relay to operate. The CK-3 relay in operating grounds the RO lead for a reorder.
>
> The CK-1, CK-2 and CK-3 relays, serve to check the incoming signals and to tell the sender whether it should register a digit in accordance with the grounds on the 0 to 7 leads.
>
> None of the CK-1, CK-2 or CK-3 relays will operate when only one channel relay is operated.

Holding circuit is connected, in place of the operating circuit, on the two channel relays that are operated.

The make contacts of the CK-1 relay connects ground through the CH2 resistance, over the J lead to the sender, break contacts TO relay, make contacts CI relay, over the L lead to the receiver, CH1 resistance, to the primary windings of the channel relays, to hold these windings energized, inturn holding operated the two relays. The ground on the CK-1 relay replaces the ground from the operated contacts of the SP relay.

The purpose of adding the CH2 resistance to this circuit is to reduce the sensitivity of the channel relays somewhat, after two of them have operated, as a protective measure to reduce the likelihood of operating a third channel.

Locking in Registration

Terminating sender circuit TRB relay is short-circuited and releases, and the TR-2 relay locks.

From ground connected to the H lead.

Terminating sender circuit CKA relay releases.

Due to ground being removed from the M lead.

The ground from relay CK-2 insures that the digit will be registered correctly on short pulses, due to the fact that the CK-2 relay is held up by the locking of the channel relays, while the ground from the SP relay insures that there is no double registration in case the incoming signals are held on longer than the time actually required for registration. The signals must be present for at least 27 milliseconds.

Terminating sender circuit TO relay operates and the TH - relays operated lock, in series.

Terminating sender circuit TO relay locks.

The TO relay receives its locking circuit from ground on the operated contacts of the CK-1 relay over the J lead.

The TO relay is marginal, operating only when two register relays have been operated and closed their locking circuits. In case one register relay only is operated this locking circuit will not be closed and at the termination of the pulse the operated register relay will release.

Receiving circuit channel relays operated for the thousands digit release.

Due to the opening of the J lead from the L lead.

The tertiary windings of the channel relays operated drive down these relays.

Ground is removed from the transmitting leads 0, 1, 2, 4 or 7 to the terminating sender.

Ground is reapplied to the vacuum tube side of the corresponding 0C to 7C resistances, restoring the screen grid voltage to normal.

Receiving circuit CK-1 and CK-2 relays release in series.

Locking circuit is opened on the TO relay.

If at the time the CK-1 relay releases, if the digit signal is still on holding the SP relay operated, ground will be held on the J lead by the SP relay, holding the locking circuit on the TO relay and preventing the J and L leads from being reconnected until the signal is off. The circuit is then ready for the next pair of digit frequencies.

Terminating sender circuit CKA relay operates.

Terminating sender circuit TR-2 relay releases.

Locking circuit is transferred for the thousands register relays.

Receiving circuit transmitting leads are transferred to the hundreds register relays.

Terminating sender circuit TO relay releases.

Registration of the Remaining Digits

The remaining digits, hundreds, tens and units are received and registered in the same manner, as already described, except that the following relays are operated or releases in each digit.

Terminating sender circuit H - relays operate.

When the two channel relays operate for the hundreds frequencies.

Terminating sender circuit TRC relay is short-circuited and releases, and the TR-3 relay locks.

When the CK-2 relay operates for the hundreds digit.

Terminating sender circuit TR-3 relay releases.

When the CK-2 relay releases on the completion of the hundreds digit.

Terminating sender circuit T - relays operate.

When the two channel relays operate for the hundreds frequencies.

Terminating sender circuit TRD relay is short-circuited and releases, and the TR-4 relay locks.

When the CK-2 relay operates for the tens digit.

Terminating sender circuit TR-4 relay releases.

When the CK-2 relay releases on the completion of the tens digit.

Terminating sender circuit U - relays operate.

When the two channel relays operate for the units frequencies.

Terminating sender circuit TRE relays is short-circuited and releases, and the CI relay locks.

When the CK-2 relay operates for the units digit.

Terminating sender circuit CI relay releases.

When the CK-2 relay releases on the completion of the units digit.

Ground is connected to the D lead to the incoming trunk circuit.

When the called number has been completely registered in the terminating sender, releasing the CI relay, ground is connected to the D lead to the incoming trunk circuit, operating the D relay. In addition the CI relay causes the circuit to continue as follows:

Terminating sender circuit TM-1 relay releases, if operated.

Terminating sender circuit RT relay releases.

Locking circuit is closed to the TM-1 relay, if operated.

Terminating sender circuit BC relay releases.

Ground is removed from the CO lead to the incoming trunk circuit.

The removal of ground from the CO lead causes the incoming trunk T relay to release. By the operation of the incoming D relay and the release of the T relay, the incoming trunk A relay is connected across the tip and ring to the originating office.

Terminating sender circuit FT relay starts to release.

Terminating sender circuit A relay releases.

Terminating sender circuit CKA relay releases.

Terminating sender circuit TC-1 relay operates.

Due to ground being connected to the D lead by the incoming trunk circuit.

The incoming trunk A relay being bridged across the tip and ring, operates and locks up the D relay. The locking ground for the D relay changes the polarity on the D lead to the TC-1 relay, from battery (negative) to ground (positive) causing its operation, as already described in step two.

Terminating sender circuit TC-2 relay operates and locks.

Locking circuit is re-established to the FT relay.

When the BC relay released it caused the FT relay to start to release, but when the TC-2 relay operates, it connects a holding circuit preventing the FT relay from releasing. This feature is to insure at this stage of the call that trunk closure took place in the incoming trunk by the operation of the A relay.

Battery is connected to the ST lead for the selection of the terminating marker connector.

Release of Terminating Sender

After the terminating marker has been selected and has received the necessary information for completing the call, it connects ground to the RL lead of the terminating sender, causing the following:

Terminating sender circuit RL relay operates and locks.

Due to ground being connected to the RL lead.

Battery is disconnected from the ST lead of the terminating marker connector circuit.

Terminating sender circuit OA or OB relay releases.

Terminating sender circuit F00 or F10 relay releases.

Terminating sender circuit A1 relay releases.

Terminating sender circuit RV relay releases.

Terminating sender circuit F - relay releases.

Ground is removed from the S lead, releasing the hold magnets, associated with the selected link.

Terminating sender circuit ON2 relay releases.

Battery is disconnected from the BAT-3 lead.

Terminating sender circuit TC-1 relay releases.

Terminating sender circuit TC-2 relay releases.

Terminating sender circuit TH-, H-, T- and U- relays, and the SP relay, release in parallel.

Receiving circuit KP-2 and KP-3 relays release, in parallel.

Terminating sender circuit FT relay releases.

Terminating sender circuit ON1 relay releases.

Battery is disconnected from the BAT-1 lead.

Terminating sender circuit SPL relay releases, if operated.

Terminating sender circuit TM-1 relay releases, if operated at this time.

Terminating sender circuit RL relay releases.

Ground is disconnected from the SB lead.

This allows the SB relay for this sender in the sender subgroup circuit, to release making this sender available for another call.

CHAPTER 6

SECTION 7

METHOD OF OPERATION

MISCELLANEOUS INFORMATION AND FEATURES

Multi-Frequency Sender	SD-25455-01
Multi-Frequency Receiver Circuit	SD-95087-01
Incoming Trunk Circuit	SD-25302-01

MISCELLANEOUS FUNCTIONS

ST SIGNAL

At the completion of the required frequencies for any call a Start Signal will follow, consisting of frequencies 7 and 10 (1500 and 1700 cycles). On calls from the crossbar #4 toll office, this signal will automatically follow the digit frequencies. On calls from a toll operator, the traffic practice will be to key the ST signal after the keying of the numerical digits.

The purpose of the ST signal is to provide a means for releasing the sender when operator errors are involved in keying or when certain trouble conditions are present in the #4 toll equipment. For instance, it is possible for an operator to key insufficient digits, especially where the called number has the same numerical digit, consecutively, for three or four of the digits.

When the total of four numerical digits are not received, there is a block because the CI relay has not released. This would require the timing circuit to function and delay its release for a period of 14 to 29 seconds. Therefore, to give an immediate release, the ST signal will be received in someone of the numerical digits, this depending upon the number of insufficient digits.

The ST signal includes the 1700 cycle frequency and will be recorded by the operation of channel relay 10, which will cause the number 10 lead to be grounded to the sender. In the sender the 10 lead is connected to the RO lead and causes the operation of the RO relay, for recording a reorder.

When the multifrequency calls has its proper number of numerical digits, the ST signal has no function in the receiving circuit. It is prevented from having any affect because of two conditions. First, the release of the BC relay will open up the T1 and R1 leads between the A relay and the IN repeat coil. Second, and the most important, the release of the CI relay opens the L lead from the J lead which is the operating circuit for the channel relays and prevents any further operation, even though the ST signal might enter the receiver.

Premature Disconnect
Before Or During Pulsing

In case the originating end should disconnect before the sender BC relay has operated, the control of the call is still with the incoming trunk. This will cause the incoming trunk A relay to release and remove ground from the ST lead, causing the disconnection.

If the call has reached the point where the sender A and A1 relays have operated and a disconnect occurs, the A relay will release causing the operation of the TC-3 relay, which locks. The TC-3 relay in operating, removes ground from the S lead releasing the link hold magnets and operates the RL relay. The RL relay operated, causes the release of the sender and its associated receiving circuit.

The TC-3 relay is slow operated to prevent its operation on momentary accidental break in the fundamental circuit.

Premature Disconnect After Frequency Pulsing

If the originating end should disconnect after the TC-1 and TC-2 relays have operated, but before the release signal is received from the terminating marker, the control for the disconnect of the call is with the incoming trunk A relay. At this particular time the TC-1 relay is being held operated from ground on the operated contacts of the incoming trunk A relay and battery from the sender C resistance. The release of the trunk A relay, in turn releases the sender TC-1 relay, which operates the TC-3 relay. This causes the RL relay to operate and restore the sender and receiving circuit to normal.

Receiver Check Relays

As already stated in a regular call the CK-1, CK-2 and CK-3 relays are for the purpose of signal counting, to recognize that a correct digit signal consisting of two frequencies and only two have been received. When more than two frequencies appear for anyone of the numerical digits, the balance in the windings of the CK-3 relay are changed. This is because three grounds are removed from the back contacts of three channel relays changing the potentiometer effect of the OC and OB to 7C and 7B resistances, thus causing the operation of the CK-3 relay in addition to the CK-1 and CK-2 relays. The CK-3 relay in operating grounds the RO lead for reorder.

Should a false KP signal reach the sender through error on the operator's part or due to a trouble in the out-sender in #4 toll, a reorder signal is returned. The KP signal to be considered false, would have to be received after the receiving circuit is unlocked. The KP signal uses in its combination the 1700 cycle frequency, but this frequency is not used in any of the other digit combinations. Therefore, if the 1700 cycle frequency is received any time after the receiver is unlocked, the operation of the 10 channel relay, will ground the number 10 lead to the sender, at which point it is connected to the RO lead.

Reorder

Whenever ground is connected to the RO lead, for a reorder, Terminating sender circuit RO relay operates and locks.

If the CK-3 relay was the cause for starting the reorder, ground is removed from the K lead by its operation. This makes the operating circuit for the TO relay ineffective.

Ground is connected to the RO lead to the terminating marker connector.

Terminating sender circuit RO-2 relay operates.

The CK-2 lead is connected directly to the T1, T2, T4 and T5 leads at the terminating marker connector.

The CK-1 lead is connected directly to the U1, U2, U4 and U5 leads at the terminating marker connector.

Terminating sender circuit RO-1 relay operates.

The CK-1 lead is connected directly to the TH1, TH2, TH4 and TH8 leads at the terminating marker connector.

The CK-3 lead is connected directly to the H1, H2, H4, H5 and OAB leads at the terminating marker connector.

The purpose of connecting the check leads to all of the register leads, except the RO lead, is to give a satisfactory check to the terminating marker, regardless as to how far the call had progressed in the sender.

Terminating sender circuit CI and TRE relays release in series.

Ground is connected to the D lead to the incoming trunk circuit.

In normal operation when the ON-2 relay operates, battery through the 226 ohm C resistance and the winding of the TC-1 relay, is connected to the D lead to the incoming trunk, which meets with battery through the winding of the D relay. Therefore, no current flow is involved at this time over the D lead. When the CI relay releases earlier than its regular point of release, which is at the completion of units registration, it connects a 10 ohm ground between the C resistance and the winding of the TC-1 relay, causing the operation of the incoming trunk D relay. The TC-1 relay is energized in the released direction.

Terminating sender circuit BC relay releases.

Ground is disconnected from the CO lead.

Removal of ground from the CO lead releases the incoming trunk T relay.

Terminating sender circuit CKA relay releases.

If operated at this time.

Terminating sender circuit A relay releases.

Terminating sender circuit TC-1 relay operates.

The operation of the incoming trunk D relay or the release of the T relay, connects the trunk A relay across the tip and ring which operates for trunk closure. The A relay in operating locks the D relay and connects a solid ground to the D lead causing the operation of the TC1 relay.

Terminating sender circuit TC-2 relay operates.

Battery is connected to the ST lead to the terminating marker connector.

The battery on the ST lead causes a terminating marker to be selected and because of the grounded RO lead, the marker does not establish a connection, but instead, sets up a reorder signal in the incoming trunk circuit by the operation of the TC, RC and RV relays. The marker having completed its functions, grounds the RL lead which affects a release in the sender as already described for a regular call.

The setting of the incoming trunk TC, RC and RV relays causes the T relay to be flashed by the OF interrupter lead and at the same time the overflow tone is connected to one side of the repeat coil. The T relay in flashing causes the A relay battery and ground to be alternately reversed on the tip and ring, as a supervision to the originating office.

More Than Two Register Relays Operated for One Digit

It was stated in step four that the TO relay is marginal and only operates when two register relays are operated for a digit. That the operating current for its primary winding depends upon the parallel of the secondary windings of two register relays. In case more than two register relays are operated, due to a false ground or short in the sender, the call will not be interrupted in its registration from the receiver. But when connection is made to the terminating marker with three or more register relays operated, a false registration is connected over the register leads. This will cause the marker to block and a trouble indicator record will be recorded. After this, a trouble release will be given to the terminating marker connector, which causes the connector to summon a different marker for a second trial. The terminating sender is unaware of this substitution.

The second marker will then encounter trouble and ground the TRL lead which is now connected through to the sender, due to this being a second trial.

Terminating sender circuit TRL relay operates and locks.

> Due to ground being connected to the TRL lead by the terminating marker.
>
> Battery is disconnected from the ST lead to the terminating marker connector.

Terminating sender circuit RL relay operates and locks.

> On a trouble release, the incoming trunk is connected through to the originating office with its A and D relays operated, as already described in step 3. The calling subscriber is connected through to the incoming trunk and receives no audible signal, busy back or overflow signal.

Only One Register Relay Operated For One Digit

If only one register relay is operated for a digit, the sender TO relay will fail to operate. Likewise, the CK-1 and CK-2 relays in the receiver circuit will fail to operate, because only one channel relay was operated. Therefore, the TRB and TR2, TRC and TR3, TRD and TR4 or TR4 and CI relays, whichever are involved, will remain operated. When the frequencies for this digit are off the SP relay releases, in turn releasing the one channel relay, which in turn releases the one register relay in the sender. Since there has been no transfer made in the sender to the next digit register relays, the next succeeding frequencies for the remaining digits will be registered falsely. This will allow for the ST signal to be recorded in the last numerical digit, thereby, causing a reorder signal, as already described.

Immediate Release of MF Sender

Provisions are made for the immediate release of the MF sender should there be any delay at the time when the tip and ring control is transferred from the incoming trunk to the sender and at the time it is transferred back to the trunk.

When the BC relay operates at the start of a call, the A relay is connected to the tip and ring for its operation. At the same time the BC relay opens the locking circuit for the FT relay. The FT relay is slow in releasing for the purpose of checking for the operation of the A1 relay. The A1 relay must operate and lock the FT relay before the locking contacts open, otherwise, the FT relay will release.

When registration is completed, the CI relay releases and operates the incoming trunk D relay, which connects the A relay for trunk closure. The operation of the A relay will cause the sender TC1 and TC2 relays to operate. The CI relay in releasing also opens the looking circuit on the FT relay. The releasing time of the FT relay now checks for the operation of the TC2 relay. The TC2 relay must operate and lock the FT relay, before the looking contacts open or else the FT relay will release.

If the FT relay releases in either of these two check conditions, the TC-3 relay will be operated and locked. Operation of the TC-3 relay, operates the RL relay for restoring the sender to normal, as previously described.

The first release time for the FT relay is approximately .1 of a second because of no soak condition, but in the second release the time is approximately .2 of a second, because there has been a soak.

Stuck Sender - Time Alarm
Min. 14 sec. - Max. 29 sec.

The timing circuit consisting of the TM1 and TM2 relays and the TM interrupter, are arranged for a two cycle timing interval. The first cycle is from the operation of the ON1 relay to the completion of registration (release of relay CI) and the second cycle, from the completion of registration to the release of the sender (release of relay ON1). Each timing cycle has an interval of minimum 14 seconds to a maximum of 29 seconds. When the terminating sender ON1 relay operates at the beginning of a call it connects the F contact of the TM interrupter to the winding of the TM1 relay,

Terminating sender circuit TM1 relay operates and locks.

When the F contact of the TM interrupter closes.

Terminating sender circuit TM2 relay operates and locks.

When the B contact of the TM interrupter closes.

Ground is connected to the TL lead to the miscellaneous circuit for terminating trouble indicator.

Ground is connected to the AL lead to the miscellaneous circuit for terminating trouble indicator.

Ground connected to the TL and AL leads results in a visual and audible alarm.

Ground is connected to the D lead to the incoming trunk circuit, if failure occurs in the second cycle.

Terminating sender circuit BC relay releases.

If failure occurs in first cycle of timing with the SP and CI relays released.

Ground is disconnected from the CO lead to the incoming trunk circuit.

This allows the incoming trunk T relay to release, connecting the A relay battery and ground to the tip and ring, respectively.

Terminating sender circuit RO relay operates and locks.

The operation of the RO relay, causes a reorder as already described.

Terminating sender circuit RT relay releases.

If failure occurs in first cycle of timing with the SP and CI relays operated.

As stated above the first timing cycle is connected for operation when the ON1 relay operates. The TM1 relay may operate immediately or as soon thereafter, when the F contact closes. When the CI relay operates it connects an additional locking circuit to the TM1 relay, if operated, and when the RT relay operates, one locking circuit is disconnected.

Upon completion of units registration, the CI relay releases and if the TM1 relay is operated at this time, it in turn releases, this being the completion of the first cycle of timing.

The RT relay is slow in releasing to allow sufficient time after the CI relay has released for the TM1 relay to return to normal before the second cycle of timing should start. If the TM1 relay is operated when the RT relay has released, it will lock up to off-normal ground. This locking circuit remains in affect until the ON1 relay releases in disconnection, thereby, completing the second cycle of timing.

Should the circuit fail in either cycle after a given time interval, operations #12 to #16 take place, causing a reorder condition to be set up in the incoming trunk.

Terminating Marker Fails To Complete Connection

If the terminating marker fails to complete a connection within a specified time, a second trial is made by a second marker. If under this condition the second marker fails to complete the connection, the TRL lead is ground to the sender operating the TRL relay. The TRL relay operated, functions as already described.

Trouble Release by Link Controller

If, due to a trouble condition the sender link and controller fails in its functions, it grounds the TR lead to the terminating sender, causing the operation of the RL relay. The operation of the RL relay restores the circuit to normal as previously described.

Hold Jack

There is a hold jack for each MF terminating sender, located on the terminating trouble indicator frame. A make busy plug is inserted in the hold jack when it is desired to hold the sender for examination after any time out or trouble release.

A plug inserted in the hold jack operates the HLD relay. This causes ground to be removed from the bottom #1 contact of the TRL relay and ground to be connected to the bottom #1 contact of the TM2 relay.

When the sender now times out, with the HLD relay operated, the TM2 relay in operating locks the F-, F00 or F10, OA or OB relays preventing the sender from returning to normal, but does not interfere with the reorder signal to the terminating marker. Should a trouble release occur with the plug in the HLD jack, the RL relay cannot operate through the contacts of the TRL relay, until the HLD relay releases.

Signaling For a Special Marker

When special incoming trunks, such as no-test and number checking, are connected to this sender, ground will be connected to the FC lead operating the SPL relay, which locks. This will cause ground to be connected to the SPL lead to the terminating marker connector, indicating that a special marker should be selected for the call. When the TC2 relay operates in its part of the call, it disconnects the SPL relay from the FC lead.

Blocking Sender Link and Controller

If, due to a trouble more than one F-0 to F-9 relay is operated or if both the F00 and F10 relays or if both the OA and OB relays are operated at the same time, ground is connected to the CK4 lead operating the LB relay. The LB relay operated prevents the ON2 relay from operating, thereby, blocking the terminating sender link and controller and causing it to timeout and give an alarm.

Making Sender Busy

Associated with each sender and located at the terminating trouble indicator is a make busy jack. Inserting a plug in the make busy jack connects ground to the MB lead, operating the sender MB relay. The MB relay can also be operated over the MB lead from the terminating marker connector, on a group busy basis, if there is a time out in the connector or if a plug is put in the group busy jack at the terminating trouble indicator.

The operation of the MB relay, grounds the SB lead to the terminating sender link, operating the SB relay in the subgroup circuit as a busy condition. It also connects 2500 ohm battery to the S lead, to permit the terminating sender test frame to identify a make busy plug condition.

Receiver BCO Jack

The BCO jack is provided to facilitate turning off the vacuum tubes when testing or adjusting the relays in the receiving circuit.

Receiver Test Jacks

Jacks T1 to T5 are provided to facilitate testing the 239 type relays in this circuit. They make it possible to isolate each winding, or groups of windings in series, and to pick them up from the front of the frame.

Contact Protection

The sender G condenser 0.5 mf in series with the G resistance 160 ohms are used to protect the 8B and 9B contacts on the ON2 relay. They are located at the TR2 relay.

The sender F condenser 0.5 mf in series with the F resistance 160 ohms are used to protect the 4T and 7T contacts of the MF receiver CK-2 relay. They are located at the TRE relay.

The sender H condenser 0.5 mf in series with the H resistance 160 ohms are used to protect the 3T and 7T contacts of the MF receiver CK-2 relay. They are located at the H lead from the MF receiving circuit.

The MF receiver KP condenser 0.5 mf in series with the KP resistance 160 ohms are used to protect the 7T and 8T contacts of the sender ON2 relay. They are located at the KP-2 and KP-3 relays.

The MF receiver CH condenser 0.5 mf in series with the CH resistance 1000 ohms are used to protect the 4T and 7T contacts of CK-1 relay. They are located at the CK-1 relay.

INCOMING TRUNK FROM TOLL
REVERSE BATTERY SUPERVISION - CONTROLLED START

This circuit is used in establishing connections between an operator at a toll switchboard or from the toll switching system #4 and subscribers in a No. 1 crossbar office, by multifrequency pulsing. It is used when the ringing of the called subscriber is to be on a controlled start basis. The multifrequency pulses are connected by the toll operator keying six digits consisting of a KP signal, four numerical digits and a ST signal or these same digits are connected automatically by the crossbar #4 toll system.

The tip and ring of this trunk will be connected to the tip and ring of a jack ended outgoing trunk at the toll switchboard or to an outgoing trunk at the #4 toll office.

Seizure of Trunk

When this circuit is seized by the toll operator plugging into the jack at the toll switchboard or automatically by the #4 toll office, the following occurs:

Incoming trunk A relay operates.

Battery to tip and ground to ring of trunk.

The polarized supervisory relay in the toll cord does not operate, but the polarized relay in the #4 toll out trunk does operate. Thus, the toll operator or the #4 toll out trunk does not get a key signal at this time.

Ground is connected to the ST lead to the terminating sender link and controller circuit.

This causes the sender link and controller to function and select a terminating MF sender to serve the call.

MF Sender Connected

When the link has cut through to an idle terminating MF sender, battery and ground is connected to the T and R leads in parallel with the battery and ground supplied by the incoming trunk circuit. After the connection of this battery and ground, the MF sender connects ground to the CO lead, causing the following:

Incoming trunk circuit T relay operates.

Incoming trunk circuit A relay releases.

Ground is removed from the ST lead to the terminating sender link and controller circuit.

The release of the incoming trunk A relay and the removal of its battery and ground from the tip and ring, has no function at the toll office because the A relay in the MF sender is maintaining a closure at this time.

When the MF sender is ready to receive the MF pulses, it reverses the battery and ground to the ring and tip, causing the cord supervisory relay to operate as an indication that the toll operator may proceed to key; or release the toll #4 out trunk supervisory relay which causes the out sender in the #4 toll office to start pulsing.

When all the digits have been recorded in the MF sender, ground is connected to the D lead to the incoming trunk, followed by the removal of ground from the CO lead, thus causing the following:

Incoming trunk circuit D relay operates.

Incoming trunk circuit D1 relay operates.

Ground is removed from the PB lead to the traffic register circuit.

Incoming trunk circuit T relay releases.

Incoming trunk circuit A relay operates.

Incoming trunk circuit D relay locks and ground is connected to the D lead to the MF sender.

Ground connected to the D lead to the MF sender indicates trunk closure to that circuit. The terminating MF sender upon receipt of this ground summons a terminating marker to serve the call.

Selection of Trunk by Marker

The terminating marker during its functions connects ground to the FC lead, causing the following:

Incoming trunk circuit F relay operates.

Ground is connected to the PC lead to the traffic register circuit.

This actuates a traffic peg count register to record the number of calls completed over the group of trunks.

Ground is connected to the M, M1 and LC leads to the incoming link and connector frame.

The T, R and S leads are connected to the TT, RT and SL leads, respectively, to the incoming link and connector circuit.

These leads will be used to make a continuity test by the terminating marker.

The RC, TC and RV leads are connected to the RC, TC and RV relays, respectively.

Incoming trunk circuit RC, TC and RV relays, will be operated, and locked, as required.

Individual Line or Ring Party	RC
Tip Party	RC-RV
Busy Signal	TC-RV
Overflow	RC-RV-TC

Release of Trunk by Marker

The terminating marker after it selects a channel to serve the call, completes its necessary tests and checks, then removes ground from the FC lead, causing the following:

Incoming trunk circuit F relay releases.

Ground is disconnected from the PC lead.

The T, TT, R, RT, SL, TC, RC and RV leads are opened from the incoming link frame and connector.

Ground is removed from the M, M1 and LC leads.

Ground through 10 ohms is connected to the S lead.

This ground is used to hold the hold magnets of the established connections.

Ringing Start Under Control of Originating Toll Office

The ringing must be started by the toll office. This is termed controlled start ringing and permits the toll operator to hold the called subscribers line without calling until such time as she is ready to ring. Where no delay exists the toll operator may ring immediately. If the call is under control of the #4 toll system, ringing current will be applied by an operator who has used this equipment to gain this trunk. Applying ringing current to this trunk causes the following:

Incoming trunk circuit R3 operates.

When ringing current is applied to tip and ring.

The A relay may follow the ringing current but the D relay which is slow release will not release from the A relay movements under this condition. The noninductive resistances in series with the A relay and which are effective when the D1 relay is operated are used to permit sufficient current to operate the R3 relay. The R3 relay is connected differentially but can operate on either winding. The purpose of this differential arrangement is to eliminate false kick-up of the R3 relay on cable surges, repeating coil surges or battery reversals on reorder, line busy and receiver hook flashes.

A holding circuit is connected to the D relay.

Incoming trunk circuit R1 relay operates and locks.

Incoming trunk circuit RA relay operates.

Due to the RC relay being operated by the terminating marker.

Short circuit is removed from the 300 ohm E protective resistance.

Incoming trunk circuit RB relay operates.

A holding circuit is connected to the RA relay.

The battery and ground on the RS relay windings is disconnected from the ring and tip of the called subscribers line.

The B condenser is discharged through the 300 ohm E protective resistance.

Incoming trunk circuit R2 relay operates and locks.

A holding circuit is connected to the RB relay.

The locking circuit for the R1 relay is opened.

The R1 relay does not release at this time unless the toll operator has released the ringing key.

Machine ringing current through the R relay is connected to the R lead and ringing ground is connected to the T lead, to the called subscribers bell.

If the called line is a tip party, the RV and RC relays will be operated, thus causing the machine ringing current to be connected to the tip instead of the ring.

Machine ringing current is connected through the D condenser to the originating office, for audible ringing tone.

Machine ringing is now connected to the called subscribers line and audible ringing tone is heard by the toll operator. The operator now releases the ringing key, causing the following:

Incoming trunk circuit R3 relay releases.

Incoming trunk circuit R1 relay releases.

Called Party Answers

When the called subscriber removes the receiver from the switchhook in answer to the ringing of the bell, the following occurs:

Incoming trunk circuit R relay operates.

Incoming trunk circuit R2 relay releases.

Machine ringing current is disconnected from the tip and ring of the called line.

Incoming trunk circuit RB relay releases.

Incoming trunk circuit RS relay operates.

Ground is connected to the S1 lead to the timing circuit for incoming trunks.

In the timing circuit for incoming trunk circuits, the S1 lead is connected to its corresponding S lead, connecting an additional ground to the 10 ohm resistance to the incoming link frame.

Incoming trunk circuit RA relay releases.

The 300 ohm E resistance is short circuited.

Incoming trunk circuit T relay operates.

The A relay battery and ground is reversed from ring and tip to tip and ring, respectively.

This battery and ground reversal toward the originating toll office operates a relay in the out trunk and extinguishes the cord supervisory lamp, as an indication that the called party has answered.

Called Party Disconnects

When the called subscriber places the receiver on the switchhook, the following occurs:

Incoming trunk circuit RS relay releases.

Incoming trunk circuit T relay releases.

The A relay battery and ground is reversed from tip and ring to ring and tip, respectively.

This reversal causes the supervisory lamp to light at the toll operators cord, as a disconnect signal.

Collection or Return of Coin

If the terminating call was established to a coin line, at this time the toll operator orders the coin collected or refunded. For each trunk of this type arranged for coin operation, there is a coin collect and coin return key located at the sender monitor position of the "A" switchboard of the local office. The toll operator orders the sender monitor operator, over a call circuit to collect or return on the trunk used for the call. When the sender monitor operator depresses the collect or return key, the following occurs:

Incoming trunk circuit CN relay operates.

> The operating ground for the CN relay is extended to the E lead to the coin control circuit.

Incoming trunk circuit RA relay operates.

> The D lead of the coin control circuit is connected to the T lead to the toll office.

Incoming trunk circuit RB relay operates.

> The tip and ring of the called line is connected to the N lead to the coin control circuit.
>
> By the connection of the tip and ring to the N lead, the coin control circuit connects either collect or return current, depending upon the key depressed, to the called line. During the action of the coin control circuit low or high tone is connected to the D lead as a signal to the toll operator that the collect or return key has been operated. When the coin is collected or returned and the collect or return key released, the coin control circuit advances disconnecting the tone from the D lead and removing ground from the C lead, causing the following:

Incoming trunk circuit CN relay releases.

Incoming trunk circuit RB relay releases.

Incoming trunk circuit RA relay releases.

Manual Rering

The sequence of events for a rering to an individual or a party line or P.B.X. without a bridge holding circuit is the same as for regular ringing started from the distant toll office. But a rering to a P.B.X. with a bridge holding circuit associated with its cords, functions differently. The bridge associated with the cord holds the RS relay operated even though the called party on the extension hangs up. The RS relay maintains the operating circuit for the T relay.

When the toll operator rerings the following occurs:

Incoming trunk circuit R3 relay operates.

Incoming trunk circuit R1 relay operates and locks.

Incoming trunk circuit RA relay operates.

Incoming trunk circuit RB relay operates.

A holding circuit is connected to the RA relay.

Incoming trunk circuit MC relay operates and locks.

A holding circuit is connected to the T relay.

Incoming trunk circuit RS relay releases.

Incoming trunk circuit RM relay operates.

A holding circuit is connected to the RB relay.

The locking circuit on the R1 relay is opened.

This locking circuit is opened for the purpose of allowing the R1 relay to follow the operation and release of the R3 relay on this type of rering.

Continuous ringing current is connected to the ring and ringing ground to the tip, to the P.B.X. cord ringing bridge.

This ringing current is held connected to the tip and ring as long as the toll operator has the ringing key operated. When the ringing key is released, the following occurs:

Incoming trunk circuit R3 relay releases.

Incoming trunk circuit R1 relay releases.

Incoming trunk circuit RM relay releases.

The C condenser and A resistance are provided to reduce the intensity of clicks on manual ringing.

Continuous ringing current is disconnected from the tip and ring of the called station.

Incoming trunk circuit RB relay releases.

Incoming trunk circuit RA relay releases.

Incoming trunk circuit MC relay releases.

Incoming trunk circuit RS relay operates.

Disconnection by Toll Office

The removal of the plug from the trunk jack at the toll office, causes the following:

Incoming trunk circuit A relay releases.

Incoming trunk circuit D relay releases.

> Ground is removed from the S lead to the incoming link frame, allowing the channel hold magnets to release.

Incoming trunk circuit D1 relay releases.

Incoming trunk circuit RC, TC or RV relay release, whichever have been operated.

Called Line Busy

If the called line is busy, the marker will, at the time that the incoming trunk F relay is operated, connect ground to the RV and TC leads and thereby operate the RV and TC relays respectively. These relays when operated lock to ground through the make contacts of the D-1 relay and provide a path for flashing the T relay at the rate of 60 interruptions per minute from interrupter lead LB. The flashing T relay intermittently reverses the battery and ground from the A relay to the originating office as a busy supervisory signal. At the same time interrupted low tone over lead "A," from interrupter lead LBT, is connected through the make contacts of the TC and RV relays, to the 7-8 coil of the repeal coil, as a line busy signal to the originating office. Disconnection in this case occurs only at the toll office and results in the release of the A, D, D-1, TC and RV relays, thereby restoring the trunk circuit to normal.

No hold magnets will have been operated on the incoming or line link frames.

All Trunks Busy

If the marker is unable to establish the connection to the called subscriber because no line junctors, incoming links or line links are available it will, after the operation of the F relay, connect ground to the RC, RV and TC leads.

This results in the operation of the RC, RV and TC relays respectively. These relays when operated lock to ground at the make contacts of the D-1 relay and provide a path for flashing the T relay at the rate of 120 interruptions per minute from interrupter lead OF. The flashing T relay reverses the battery and ground to the originating office as an overflow supervisory signal. At this time low tone over lead "A" from the OFF interrupter is connected through the make contacts of the TC and RV relays to the 7-8 coil of the repeal coil, as an overflow signal. Disconnection occurs as described for a called line busy. No hold magnets will have been operated on the incoming or line link frames.

Premature Disconnect

If the disconnection by the toll office occurs before the connection is established, the A relay will release removing ground from the D lead as a disconnect signal to the sender and release the D relay. This sender will release removing ground from the CO lead restoring the trunk to normal.

Timed Release

Should the called subscriber fail to disconnect when the calling subscriber or D-1 operator has disconnected, the release of the incoming trunk D-1 relay, with the trunk RS relay operated, connects ground to the A lead to the timing circuit for incoming trunks. When the RS relay previously operated, it connected ground to the S-1 lead to the timing circuit, through normal contacts of a relay in the timing circuit, to the S lead to the incoming trunk from which point it was connected to the S lead to the incoming link circuit. This ground at the present time is holding operated the hold magnets of the established connection. After approximately 112 to 232 seconds have elapsed, the timing circuit functions and opens the above described path thereby releasing the operated hold magnets. When the hold magnets, release, the trunk circuit S relay releases and the trunk circuit is restored to normal.

CHAPTER 6

SECTION 8

METHOD OF OPERATION

Multi-Frequency Sender Circuit	SD-25455-01
Multi-Frequency Receiver Circuit	SD-95536-01
Incoming Trunk Circuit	SD-25295-01

MARCH 1954

Complete OS and SC's for the multifrequency terminating sender will be available at a later date. The following written material is presented on a temporary basis to be used with OS 416-2 sheets 3 and 4 and the SD drawings.

PREPARATION OF RECEIVING CIRCUIT

Each signaling receiving circuit has seven vacuum tubes and six thyratron tubes. The seven vacuum tubes consist of three #403B pentodes and four #396A double triodes. The six thyratrons are coded #2D21.

The receiving circuit in its equipment layout has five removable plug-in type units, namely, one "volume limiter", one "SP-Bias control" and three "channel units." These units may easily be replaced in case of trouble.

The volume limiter uses two pentode #403B vacuum tubes arranged as a push-pull amplifier for the purpose of providing adequate amplification of the incoming MF signals. It also limits strong signals to such value that they will not cause interfering signals in channels other than those for the two frequencies received.

The SP-Bias control unit uses a #396A double triode vacuum tube, one half of which supplies the signal present circuit and the other half is the variable bias control circuit. The variable bias control circuit is not effective until after the receiving circuit is unlocked by the KP signal.

Each of the channel units use a #396A vacuum tube and two #2D21 thyratrons. Each channel unit is associated with a 200-type filter. The #396A tube is a rectifier, each half rectifying its associated channel when passed through the band-pass filter and then applied to the associated #2D21 hot cathode thyratron tube causing a fast operating relay with its winding in the plate circuit of the thyratron to operate.

The equipment is so arranged that the six frequencies are paired so that two channel filters for the two lowest frequencies are housed in a single case, the two middle frequencies and the two high frequencies in a second and third filter, respectively.

The signal present circuit SP tube uses a #415A pentode, which serves to indicate that the signal present is within the band of frequencies from 700 to 1700 cycles.

The vacuum tube filament heaters of all tubes in a receiver circuit are wired in parallel and are supplied with 6.3 volts ac from a filament transformer mounted on the same bay as the receivers. The heaters per receiver are energized by inserting a polarized plug into a receptacle associated with the FIL transformer. Provisions are made for automatic transfer to the dc office battery in case of a power failure.

SEIZURE OF INCOMING TRUNK

When this incoming trunk circuit is normal it has the A relay connected with battery on the tip and ground on the ring toward the distant originating offices. This trunk will be associated with either an out trunk in the toll switching system No. 4 or a jack ended trunk at a toll switchboard.

When the incoming trunk is seized by either the No. 4 toll system or a toll operator for a multifrequency termination, a polarized supervisary relay is connected across the tip and ring.

Incoming trunk circuit A relay operates.

> The battery and ground on the A relay causes the polarized relay in the No. 4 toll out trunk to operate, but the polarized relay in the toll switchboard cord circuit will not operate. In the No. 4 toll equipment it is indicating an off-hook supervision and at the toll switchboard an on-hook supervision.

Ground is connected to the ST lead to the terminating sender link and controller circuit.

> Ground connected to the ST lead causes the terminating sender link and controller circuit to function except that it will require the services of a multifrequency sender for the call.
>
> The incoming trunks for these two types of terminating calls will be included in the same trunk group and must appear in the primary switches of the terminating sender link frame, co that the likls have access to multifrequency senders.

SENDER SEIZURE AND REGISTRATION OF FRAME INDICATION

When the controller circuit has progressed to the selection of an idle multifrequency sender, by the operation of an S-relay, ground is connected to the SC lead.

Terminating sender circuit SC-1 relay operates.

> From ground on the SC lead coming from the break contacts of either the GAT or GBT relay.

Terminating sender circuit SPK relay operates, if required.

> From ground on the FC lead of special incoming trunk circuits.
>
> If an incoming trunk circuit requires the use of a special marker it connects ground to its FC lead.

METHOD OF OPERATION

PURPOSE RM 6-3

These circuits are used to terminate calls in the No. 1 crossbar system, incoming from No. 4, No. 5 and tandem crossbar systems and from toll switchboards arranged for multifrequency out pulsing.

The incoming trunk circuit used in conjunction with the terminating sender link circuit and the terminating marker circuit, sets up the proper ringing, supervisory and transmission conditions. It can be arranged through optional wiring for an on-hook or off-hook supervision to the originating end.

The terminating sender link and controller circuit provides a crossbar switch link arrangement for connecting this type of trunk to an idle terminating multifrequency sender circuit.

The terminating multifrequency sender circuit and its associated multifrequency signaling receiving circuit, is used to permit MF out pulsing senders or a toll operator to establish a connection to a subscriber in a crossbar office. The desired number is received by the MF receiving circuit and registered directly in the MF sender. Upon completion of registration a terminating marker is summoned which then completes the connection from the incoming trunk to the called subscriber's line.

The multifrequency receiving circuit is permanently connected with a terminating multifrequency sender and is used to receive signals in the form of pulses of voice-frequency current from a keyset or sender and to convert the signals into direct current pulses to operate various code combinations of relays in the associated sender circuit.

DESCRIPTION

TERMINATING SENDER FRAME

The terminating multifrequency senders can be mounted on the same bays, with the full selector senders or "B" senders, or in a bay of exclusively MF senders. There are five senders to a frame, numbered zero to four.

MULTIFREQUENCY RECEIVER FRAME

The multifrequency receiver frame is a single sided bay mounting six receiving units and designated MFR, and numbering from zero up in the office. The receiving circuits on a frame are designated zero to five.

Each receiving unit is connected to its associated terminating MF sender by 19 leads. Each sender unit is connected to its associated terminating marker connector by 33 leads.

Ground is connected to the SPL lead to the terminating marker connector.

Terminating sender circuit F00 or F10 relay operates.

> From ground connected to the correspondingly numbered F00 or F10 lead at the terminating sender link C or TG relay, whichever is required.
>
> If the incoming trunk appears on one of the incoming link frames whose number is in the group 0 to 9, the F00 relay is operated. If it is in the group 10 to 19, the F10 relay is operated.

Ground is connected to the F10 lead to the terminating marker connector if the F10 relay operates.

The CK4 lead is connected to the F10 lead to the terminating marker connector if the F00 relay operates.

Terminating sender circuit FT relay operates.

Terminating sender circuit OA or OB relay operates.

> From ground on the OA or OB lead and furnished at the TG- relay when office "unit" information is required.
>
> Ground is connected to the OAB lead to the terminating marker connected if the OB relay operates.

Terminating sender circuit SC-2 relay operates.

Terminating sender circuit F- relay operates.

> From ground on one of the F0 to F9 leads.
>
> There are ten F- relays, numbered 0 to 9. The one to operate corresponds in number to one of the F0 to F9 leads that is grounded by the terminating sender link C or TG relay, whichever is required.

Ground is connected to leads F1, F2, F4 and F5 according to the incoming link frame required for this call.

Frame	Leads	Frame	Leads
0 or 10	None	5 or 15	F5
1 or 11	F1	6 or 16	F1 and F5
2 or 12	F2	7 or 17	F2 and F5
3 or 13	F1 and F2	8 or 18	F1, F2 and F5
4 or 14	F4	9 or 19	F4 and F5

SENDER OFF-NORMAL CONTROL

After the controller has grounded the SC lead to the sender, it proceeds to made its sleeve continuity test and the double cpnnection test. Upon completion of a satisfactory double connection test, the controller connects ground to the GS lead of the sender.

Terminating sender circuit ON1 relay operates.

> From ground on the GS lead.

Ground is connected to the SB lead to the terminating sender link and controller circuit.

> The ground connected to the SB lead causes the associated SB relay to operate in the sender subgroup circuit, making the sender busy to other calls.

The OA or OB relay locks, if operated.

The operated F- relay locks.

The operated F00 or F10 relay locks.

The Spl relay locks, if operated.

Groundis connected to the SB punching for the holding time recorder.

Battery is connected to the BAT-1 lead to the windings of the receiving circuit KP1 and KP2 relays.

Terminating sender circuit RV relay is released, if operated.

> The RV relay is a non-biased polarized relay its windings being connected differentially. Ground is connected to the primary and secondary windings by the operation of the ON1 relay. When both windings are energized, the energy in the secondary winding overpowers the energy in the primary winding, thereby insuring that the relay has its back contact closed. The polarity of the secondary winding is in the released direction.

Terminating sender circuit TM1 relay operates and locks.

> If the F contact of the TM interrupter is closed.

SENDER PREPARED FOR REGISTRATION

Terminating sender circuit TRB and TR-2 relays operate in series.

The TRB relay locks and the TR-2 relay holds.

> The receiving circuit 0, 1, 2, 4, and 7 leads are connected to the TH-0, TH-1, TH-2, TH-4, and TH-7 relays, respectively.

Terminating sender circuit TRC and TR-3 relays operate in series.

The TRC relay locks and the TR-3 relay holds.

Terminating sender circuit TRD and TR-4 relays operate in series.

The TRD relay locks and the TR-4 relay holds.

Terminating sender circuit TRE and CI relays operate in series.

The TRE relay locks and the CI relay holds.

SENDER MADE BUSY

Before dismissing the terminating sender link controller it is necessary to make the sender busy to other calls and lock-in the selected link hold magnets under control of the sender.

When the ON1 relay connects ground to the SB lead, the associated SB relay in the sender subgroup circuit operates and causes a ground to be returned on the BSlead.

Terminating sender circuit ON2 relay operates.

> From ground on the BS lead and provided the required F- relay has been operated.
>
> The FT relay locks.
>
> A holding circuit is connected to the ON1 relay.
>
> Ground is connected to the S lead, locks in the primary and secondary hold magnets associated with the selected link.

Ground is connected to the RL lead to the terminating sender link.

> This ground causes the terminating sender link controller to release.

Receiving circuit KP relay primary winding is energized.

From battery on the BAT-2 lead.

The KP relay is a nonbiased polarized relay. With the receiving circuit normal, the secondary winding is energized from battery on the KP jack to ground on the back contact of the SP relay. This ground is also short circuiting the E, F, and G condensers. The polarity on the secondary winding is in the release direction and overpowers the effect of the primary (operate) winding, therefore, the relay is held on its back contact.

At this stage of the call the receiving circuit is considered locked, for as long as the KP1 and KP2 relays are normal the battery on the K resistance is holding a negative potential on the plates of the channel thyratrons 0, 1, 4, and 7. The plates of the 2 and 10 thyratrons are helk open.

At this point, it should serve well to remind those who are starting contact with the receiving circuit that the central office battery is grounded on the positive side. This is pointed out for the purpose of appreciating the terminology of positive bias and negative bias, which shall be used from here on in describing the receiving circuit, that it means central office ground and central office battery, respectively. That the positive bias requires the use of the ground convention and that negative bias requires the use of the battery convention. It may also be expressed as positive potential or negative potential.

Terminating sender circuit TO relay tertiary winding is energized.

The TO relay is a nonbiased polarized relay. The energizing of the tertiary winding is to insure that the relay is on its back contact.

RELEASE OF TERMINATING SENDER LINK CONTROLLER

When the ON2 relay operated ground was connected to the RL lead causing the terminating sender link controller to release. When the sender subgroup circuit S- relay releases ground is removed from the SC lead.

Terminating sender circuit SC1 and SC2 relays release.

Due to ground being removed from SC lead.

Terminating sender circuit BC relay operates.

Ground is connected to the CO lead, through the selected link, to the incoming trunk.

The connection of ground to the CO lead of the incoming trunk causes the T relay to operate.

Terminating sender circuit A relay operates.

The battery and ground on the A relay is connected in series with the IN repeat coil in the receiving circuit, to the tip and ring of the incoming trunk, which at this time is battery tip and ground ring. It should also be noted that at the instant in which the sender A relay is operating the incoming trunk T relay is operating to remove the incoming trunk A relay from the tip and ring. This change over results in no change at the originating office.

Terminating sender circuit CKA relay operates.

Terminating sender circuit FT relay starts to release.

Terminating sender circuit A1 relay operates and locks.

Locking circuit is reestablished to the FT relay.

When the BC relay operated it caused the FT relay to start to release, but when the A1 relay operates it connects a holding circuit preventing the FT relay from releasing. This feature is to insure that the continuity of the tip and ring from the trunk to the sender, to the receiving circuit is complete and that the A relay has operated.

Terminating sender circuit RV relay operates.

The RV relay is made slow operate by condenser timing, in order to allow sufficient time for the imcoming trunk A relay to be disconnected from the tip and ring, in order that the control of the call be in the terminating sender.

When the ON1 relay operated it caused the primary and secondary windings of the RV relay to be energized. The primary is the operate winding and the secondary the release winding. By the operation of the A1 relay, direct ground is disconnected from the secondary winding at the same time the short circuit is removed from the RV condenser. Battery through the secondary winding then charges the condenser, this charging current holding the relay normal. As the condenser becomes charged, this current decreases until the energy in the primary is greater than the secondary, thus causing the relay to operate.

START PULSING SIGNAL

From the beginning of the call, when the incoming trunk A relay was operated, until this point is reached in its operation, the originating office has been waiting for a signal to start pulsing. This signal is reversed battery, that is, battery on the ring and ground on the tip.

With the tip and ring of the incoming trunk now cut through to the terminating sender and the receiving circuit ready, the following takes place upon the operation of the RV relay.

Terminating sender circuit SP relay operates.

Battery and ground on the tip and ring, respectively, are reversed.

The primary and secondary windings of the sender A relay which are connected to the tip (T1) and ring (R1), respectively, are transferred to the ring and tip, causing the battery and ground to be reversed to the originating office.

Terminating sender circuit RT relay operates.

One of the locking circuits for the TM-1 relay is opened.

MULTIFREQUENCIES

This type of call from an originating office to a No. 1 crossbar office, is on a multifrequency basis. This consists of transmitting two frequencies of various combinations for each digit required. Five digits are required for any complete termination, one digit known as the KP signal and the four numerical digits of the called number.

The multifrequency signals may be sent out by an operator using a keyset which connects the proper frequencies for each digit to the trunk or by another sender. The two frequencies for each digit are received instantaneously. The multifrequencies are ac voltages, superimposed onto the tip and ring dc circuit, which is being supplied by the battery and ground on the terminating sender A relay.

The signalling frequencies used for the multifrequency pulsing are 700, 900, 1100, 1300, 1500 and 1700 cycles, which have been designated 0, 1, 2, 4, 7, and 10 respectively. Frequencies 0 to 7 are used for digit codes and frequency 10 is used in combination with frequency 2 for the KP signal. The following chart indicates the combinations used.

Frequency & Designation		DIGIT CODES											
		0	1	2	3	4	5	6	7	8	9	KP	ST
												X	X
1700	(10)												X
1500	(7)	X							X	X	X		
1300	(4)	X				X	X	X					
1100	(2)			X	X			X			X	X	
900	(1)		X		X		X			X			
700	(0)		X	X		X			X				

X Frequency Used.

It will be noted from the above chart that the additive system is used for determining the two frequencies required for all digits except zero and the KP signal. For digits 1 to 9 the two frequency designations are added together by using the smallest combination for the addition. For digit zero and the KP signal they add up to 11 and 12, respectively.

KP SIGNAL FREQUENCIES ON

When the receiving circuit IN repeat coil is cut through to a trunk or a keyset circuit at the beginning of a call, there is a brief period during which it may be exposed to speech or noise currents, which, if it were necessary to receive digit pulses, might cause false registrations in the associated sender circuit. To prevent this, the receiving circuit is normally held in a condition wherein digits cannot be registered intil after it has been unlocked by the functioning of the KP signal. This signal is composed of a relatively long period of frequencies 2 and 10, which must be on for the required time without presence of the other frequencies 0, 1, 4, and 7.

When the sender SP relay operates and reverses the battery and ground, the reversal is a signal to the originating equipment to send the KP signal. If the originating office was a manually operated one, the operator depresses her KP key when she jacks into the outgoing trunk multiple and then waits for a lamp signal on her position circuit before she proceeds to key any of the digit signals. The operator pressing the KP key does not cause the KP signal to be sent at that time, but causes her cord circuit to be associated with the position keyset equipment. The equipment associated with the outgoing trunk had in the meantime caused an MF sender to be selected at the distant end. When the distant MF sender reverses its battery and ground, a relay in the keyset equipment operates and sends the KP signal after which the keyset signals the operator to commence keying the numerical digits. If the originating equipment is a #4, #5 or tandem crossbar office, all the signalling is done automatically.

When the KP signal frequencirs are present in the primary coils of the IN repeat coil, they are induced into the secondary coils.

> Receiving circuit L1 and L2 limiter tubes function to ampligy and limit the KP signal to the 0, 1, 2, 4, 7, and 10 filters.

VOLUME LIMITER

Vacuum tubes L1 and L2 and their associated input and output circuits constitute a volume limiter. They provide adequate amplification of incoming pulses to cause operation of desired channel relays, but at the same time limit the amplitude of high level signals to such a value that they will not cause interfering signals in channels other than those for the two frequencies being received.

The L1 and L2 tubes are arranged for push-pull amplification. In push-pull amplicication each tube works on one half of the ac cycle.

The limiting action is obtained by means of the grid-leak design between the control grids and the input transformer. When the incoming signal causes the control-grid to become more positive with respect to the cathode, during that portion of the input signal the grid draws current during its half cycle. When this condition is reached the power output increases very slowly with further increases in the grid voltage. The actual point at which limiting occurs is controlled by the voltage on the screen grids and on the cathodes, as well as by that on the control grids. The desired value for the screen grids are obtained from variable potentiometer P. The potential on the cathodes is obtained from voltage drop in resistance L3.

The two incoming frequencies 2 and 10 pass through the limiting amplifier for amplification or amplitude limiting as required. At the output of the limiter the energy divides into three paths only two of which are effective to register the KP frequencies.

Receiving circuit A2 and A10 tubes function for rectification of 2 and 10 frequencies.

CHANNEL UNITS

Each channel circuit of which there are six, one for each frequency, consists essentially of a filter, one half of a #396A vacuum tube, a 2D21 hot cathode thyratron tube and a fast operating relay with its winding in the plate circuit of the thyratron. The channels are paired in using the two halves of the #396A vacuum tube as rectifying diodes.

A portion of the output from the volume limiter for the 2 and 10 frequencies is induced into the secondary of the output transformer. The induced signal in the secondary is terminated in a T pad consisting of the A, B, and C resistors and connected to the channel band pass filters. The 2 and 10 frequencies now traverse their respective filters and are applied to the plate and grid of their associated A tube in the channel unit.

The A tubes are used as diode half-wave rectifiers with the cathode follower principle involved. It will be noted that the cathodes of the A channel tubes are biased negative to the fixed potential on the D resistor. This same source is the fixed bias for the control grids of the channel thyratron tubes. At this particular time the 0, 1, 4, and 7 thyratrons are nonconductive because of the negative potential connected to their plates from the LK resistor. The 2 and 10 thyratrons are nonconductive because their plate circuits are open. Thus, the channel A tubes while operative at this time do not cause any channel operation until the receiver is unlocked. However, the rectified signal does have an effect on the SP tube.

SIGNAL PRESENT CIRCUIT - KP SIGNAL

The SP vacuum tube has connected to its plate the secondary winding of the SP relay. Its primary winding is energized in the released direction.

The control and suppressor grids of the SP tube are biased negative through the 7 megohm resistors SPG and SPS, respectively, to the potential on the D resistor which in conjunction with the E and F resistors forms a potentiometer. This negative bias has a value of 18 volts which holds the SP tube far beyond cutoff.

The resultant rectified dc voltage by the 2 and 10 A tubes is now applied to the bias on the control and suppressor grids of the SP tube. This voltage being positive in potential reduces the negative effect of the normal bias, but in itself, it is still not capable of removing the cutoff value on the SP tube to the point where there is plate current. The complete removal depends upon the action of the variable bias circuit.

Receiving circuit BR tube functions to amplify the incoming signal.

Due to a small part of the ac signal voltage taken from the plate of the L1 tube.

VARIABLE BIAS CIRCUIT

The variable bias circuit is used to determine whether the signal that is present is within the operating band of frequencies for operation of the receiver. If the signal proves to be in the proper range, an added value is connected to the control and suppressor grid of the SP tube for the operation of the SP relay.

The #6, #7, and #8 side of the double triode BR tube is used as an amplifier. Connected to the #7 control grid is the variable potentiometer BIAS, which connects to a fixed potentiometer formed by resistors AD and AE, between negative 48 volts and AF resistor and is coupled by the AB capacitor to the germanium varistors A and B. The #7 control grid and its network is coupled to the plate of the L1 tube in the volume limiter circuit by the AA capacitor.

The #2, #3, and #4 side of the BR tube is nonconductive at this time because of the additional negative bias on the #3 control grid from the U resistor is connected by the top 1 and 2 of the KP1 relay.

When the incoming amplified signal from the L1 tube is applied to the #7 control grid of the BR tube, it is amplified and passed to the A and B varistors. These varistors work as rectifier into a voltage doubler circuit by means of the N resistor as a termination. The positive voltage developed across the N resistor is added to the bias on the control and suppressor grid of the SP tube which is now sufficient to cancel the cutoff value and allow current to flow in the secondary winding of the SP relay.

Receiving circuit SP tube conducts as a dc amplifier.

Receiving circuit SP relay operates.

Due to current in the secondary winding.

The current now flowing in the secondary winding is in the operate direction and due to the energy being greater than in the primary winding causes the SP relay to operate.

Receiving circuit LK relay operates.

The circuit for operating the LK relay is from battery winding over lead L to sender, make contacts CI relay, break contacts TO and TM2 relays, over J lead to receiver, make contacts SP relay to ground.

The 130-volt positive battery is closed to the windings of the channel relays 0, 1, 4, and 7.

The CK3 and CK2 relays are short-circuited at this time through the top 4 and 5 of the KP2 relay.

Short circuit is removed from the E, F, and G capacitors.

The KP relay is made slow operate by condenser timing to insure that the KP signal is present for its proper duration. The primary is the operate winding and the secondary, the release winding. With the SP relay operated direct ground is remived from the secondary winding and at the same time the short circuit is removed from the E, F, and G condensers. Battery through the secondary winding now charges these condensers, this charging current holding relay KP down. As the condensers become charged, the secondary current decreases until the energy in the primary winding is greater than that in the secondary, thus causing the KP relay to operate, The KP relay takes approximately 55 milliseconds to operate.

THIRD FREQUENCY GUARD FOR KP SIGNAL

As previously stated it is necessary that frequencies 2 and 10 be received for a definite length of time without frequencies 0, 1, 4, and 7 being present, if the receiver is to be unlocked. If during the timing period of the KP relay, one or more frequencies other than the 2 and 10 are present, the KP timing cycle is immediately cancelled and the receiver remains locked.

Any additional frequencies present the channel A tubes rectify and cause the associated thyratron to fire. This is possible on only the 0, 1, 4, and 7 channels after the LK relay has operated. When the LK relay applies the 130-volt positive battery to the windings of the 0, 1, 4, and 7 channel relays, the existing negative potential on the LK resistor is cancelled, thus, allowing the thyratron to fire and operate the associated channel relay.

The corresponding channel relay in operating will apply a short-circuiting ground to the E, F, and G capacitors. This restores the full bias current to the secondary winding of the KP relay preventing it from operating. If no additional frequencies other than the 2 and 10 are present, the following occurs:

Receiving circuit KP relay operates.

At the completion of the condenser timed period.

The KP relay is energized in the released direction.

When the 2 and 10 channel relays operate the short-circuiting ground is removed from the G, E, and F capacitors allowing them to charge up from battery on the KP jack thru the secondary winding of the KP relay. This charging period is the time factor and holds the KP relay released while current is following in the secondary winding. As the capacitors become charged this current decreases until the energy in the primary is greater than the secondary, thus causing the KP relay to operate. It will be noted that the time fadtor is small when compared to the condenser timing of the sender RV relay.

KP SIGNAL FREQUENCIES OFF

When the KP signal frequencies are disconnected from the fundamental circuit, the L1, L2, BR, SP and channel A tubes restore to their static condition.

Receiving circuit SP relay releases.

Receiving circuit LK relay releases.

The 130-volt positive battery is disconnected from the windings of channel relays, 0, 1, 4, and 7.

Receiving circuit KP1 and KP2 relays operate, in parallel.

Receiving circuit KP1 relay locks and the KP2 relay holds in parallel.

The negative bias on the control and suppressor grids of the SP tube are changed to the AA and AB resistors at the BR tube.

The leads for the rectified positive bias from the A2 and A10 tube are disconnected from the control grid of SP tube.

The windings of the 2 and 10 relays are now connected in parallel with windings of the 0, 1, 4, and 7 relays.

The negative lock on the #3 control grid of the BR tube is removed.

The negative locking potential connected to the plates of the thyratrons, is now removed.

THOUSANDS DIGIT FREQUENCIES ON

The receiving circuit is now ready to receive the code and numerical digit frequencies which follow immediately after the KP signal. Since the digit frequencies will be of a shorter duration than the KP signal frequencies, the circuit has modified itself by the operation of the KP1 and KP2 relays to now include a time constant during the registration of digit frequencies.

When each digit frequencies are received the receiving circuit functions as already described on operations #28 and #29.

At this time the channel thyratrons have the 18-volt negative bias from the potentiometer circuit of E, F, and D resistors. In addition the BR tube is applying its amplified signal from the L1 tube to the voltage doubler A and B varistors whose elements are rectifying a dc bias to the control grids of the thyratrons. Here the bias voltage and the positive rectified signal voltage are added and the resulting potential on the control grids of the two thyratrons causes these grids to be at breakdown potential. But the thyratrons cannot fire until the signal present circuit functions and connects the required plate voltage.

At the same instant that the control grids of the channel thyratrons are conditioned, the SP filter is applying the incoming signal to the primary winding of the SP transformer. The SP transformer is now operative because the operated KP1 relay has removed the locking negative bias from the #3 of the BR tube. The

Receiving circuit BR tube functions on section 2, 3, and 4 elements.

The SP band pass filter will pass all digit frequencies received from 600 to 1780 cycles. The prime function of this filter is the elimination of line noise products that could affect the signal present circuit. The filter terminates in a 7000 ohm impedance bridge by a potentiometer circuit using resistors R and 3.

> The signal is induced into the secondary winding of the SP transformer. The voltage output of the transformer is applied to the #3 control grid of the BR tube which now functions as a rectifier. The #2 cathode in following this rectification now has a higher dc voltage which is connected through the P resistor to the control and suppressor grids of the SP tube.

Associated with the P resistor are capacitors C and H which serve as filters and provide a time constant in the signal present circuit during digit registration. The capacity of capacitor H is selected to provide a signal recognition time of approximately 20 milliseconds. Its purpose is to permit the transient condition in the filters of the unwanted channels to die out before the signal present circuit makes available the plate voltage to fire the thyratrons.

The germanium varistors C, D, and E connected across the P resistor serve to reduce the time constant of the P resistor and H capacitor combination at the end of a digit signal and thus reduce the release time of the SP relay.

When the rectified signal is applied to the control and suppressor grids of the SP tube, operations #31 to #33 take place as previously described and c cause the following:

Receiving circuit channel thyratrons (two) fire and their associated channel relay operates, in series.

> Due to the plate voltage being connected by the operation of the LK relay.
>
> The channel thyratrons are hot cathode four element gas rectifiers having a control grid. When the grid voltage of the thyratron is raised to a point more positive than the negative cutoff value the gas ionizes and current flows. After ionization the grid loses control over the discharge and the only possible way to reduce the ionization is to reduce the positive plate voltage to zero for a sufficient time period. The tube is either fully conduction or completely cut off.

Ground is connected to a combination of two leads of the group 0, 1, 2, 4, and 7 to the MF sender.

REGISTRATION OF THOUSANDS DIGIT

When the two channel relays of the group 0, 1, 2, 4, and 7 have operated for the thousands digit, two leads are grounded to the terminating sender, each one being of the same designation as the relay grounding the lead. This causes the following to take place:

Terminating sender circuit TH- relays (two) operate.

Associated TH- leads are grounded to the terminating marker connector circuit.

The terminating marker connector TH- leads that are not required are connected to the CK-1 lead.

DIGITS PULSED ADDITIVE SYSTEM

DIGIT NUMBER	0	1	2	3	4	5	6	7	8	9
TERM. SENDER REG. RELS. OPTD.	4-7	0-1	0-2	1-2	0-4	1-4	2-4	0-7	1-7	2-7
THOUSANDS LEADS GROUNDED TO MKR. CONN.	None	1	2	1 2	4	1 4	2 4	1 2 4	8	1 8
OTHER DIGIT LEADS GROUNDED TO MKR. CONN.	None	1	2	1 2	4	5	1 5	2 5	1 2 5	4 5

THIRD FREQUENCY GUARD FOR DIGIT FREQUENCIES

Receiving circuit CK2 relay operates.

The CK2 relay operates when current flows through two or more of resistors 0, 1, 2, 4, 7, and 10.

The CK3 relay does not operate in the series circuit as long as a combination of only two frequencies are received per numerical digit. Should one or more additional frequencies be received, the current then in the parallel of three or more of resistors 0, 1, 2, 4, 7, and 10 causes sufficient current in the primary winding of the CK3 relay to overcome the release effects in the secondary and operate the relay. Normally, battery and ground on the secondary winding, in the released direction, holds the CK3 relay nonoperated. The CK3 relay operated grounds the RO lead to the sender for reorder, as described later.

Neither the CK2 relay nor the CK3 relay will operate when only one channel frequency is received.

Ground is removed from the E resistor.

The removal of this ground causes the grid bias on the thyratrons of unused channels to become 48 volts negative, to insure the static condition of these channels.

Holding circuit is connected to LK relay.

This circuit is over the L and J leads.

LOCKING IN REGISTRATION

Terminating sender circuit TRB relay is short-circuited and releases, and the TR-2 relay locks. From ground connected to the H lead.

Terminating sender circuit CKA relay releases.

Due to ground being removed from the M lead.

The ground from relay CK2 on the J lead insures that the digit will be registered correctly on short pulses, due to the fact that the KC2 relay is held up by the LK relay, while the ground connected to the J lead by the SP relay insures that there is no double registration in case the incoming signals are held on longer than the time actually required for registration. The signals must be present for at least 27 milliseconds.

Terminating sender circuit TO relay operates and the TH- relays operated (two) lock, in series.

Terminating sender circuit TO relay locks.

The TO relay receives its locking circuit from ground on the operated contacts of the CK2 relay over the J lead.

The TO relay is marginal, operating only when two gegister relays have been operated and closed their locking circuit. In case one register relay only is operated there will not be sufficient current to operate the TO relay and at the termination of the pulse the operated register relay will release.

Receiving circuit LK relay releases.

Due to the opening of the J and L leads.

Receiving circuit CK2 relay releases.

The negative bias of 48 volts at the D resistor is changed to the normal 18 volt bias.

If when the CK2 relay releases and the digit frequencies are still on, the TO relay remains locked to the SP relay operated.

Receiving circuit channel thyratrons (two) are de-ionized and their associated channel relays release, in series.

Due to the removal of the plate voltage.

Ground is removed from the transmitting leads 0, 1, 2, 4, and 7.

Terminating sender circuit CKA relay operates.

Terminating sender circuit TR-2 relay releases.

Locking circuit is transferred for the thousands register relays.

Receiving circuit transmitting leads are transferred to the hundreds register relays.

Terminating sender circuit TO relay releases.

REGISTRATION OF THE REMAINING DIGITS

The remaining digits, hundreds, tens, and units are received and registred in the same manner as already described, except that the following relays are operated or released in each digit.

Terminating sender circuit H - relays (two) operate.

When the two channel relays operate for the hundreds frequencies.

Terminating sender circuit TRC relay is short circuited and releases, and the TR-3 relay locks.

When the CK-2 relay operates for the hundreds digit.

Terminating sender circuit TR-3 relay releases.

When the CK-2 relay releases on the completion of the hundreds digit.

Terminating sender circuit T - relays (two) operate.

When the two channel relays operate for the tens frequencies.

Terminating sender circuit TRD relay is short circuited and releases, and the TR-4 relay locks.

When the CK-2 relay operates for the tens digit.

Terminating sender circuit TR-4 relay releases.

When CK-2 relay releases on the completion of the tens digit.

Terminating sender circuit U - relays (two) operate.

When the two channel relays operate for the units frequencies.

Terminating sender circuit TRE relays is short circuited and releases, and the CI relay locks.

When the CK-2 relay operates for the units digit.

Terminating sender circuit CI relay releases.

When the CK-2 relay releases on the completion of the units digit.

Ground is connected to the D lead to the incoming trunk circuit.

When the called number has been completely registered in the terminating sender, releasing the CI relay, ground is connected to the D lead to the incoming trunk circuit, operating the D relay. In addition the CI relay cuases the circuit to continue as follows:

Terminating sender circuit TM-1 relay releases, if operated.

Terminating sender circuit RT relay releases.

Locking circuit is closed to the TM-1 relay, if operated.

Terminating sender circuit BC relay releases.

Ground is removed from the CO lead to the incoming trunk circuit.

The removal of ground from the CO lead causes the incoming trunk T relay to release. By the operation of the incoming D relay and the release of the T relay, the incoming trunk A relay is connected across the tip and ring to the originating office.

Terminating sender circuit FT relay starts to release.

Terminating sender circuit A relay releases.

Terminating sender circuit CKa Relay releases.

Terminating sender circuit TC-1 relay operates.

Due to ground being connected to the D lead by the incoming trunk circuit.

The incoming trunk A relay being bridged across the tip and ring operates, and locks up the D relay. The locking ground for the D relay changes the polarity on the D lead to the TC-1 relay, from battery (negative) to ground (positive) causing its operation, as already described in Step 2.

Terminating sender circuit TC-2 relay operates and locks.

Locking circuit is reestablished to the FT relay.

When the BC relay released it caused the.FT relay to start to release, but when the TC-2 relay operates, it connects a holding circuit preventing the FT relay from releasing. This feature is to insure at this stage of the call that trunk closure took place in the incoming trunk by the operation of the A relay.

Battery is connected to the ST lead to the terminating marker connector.

Battery is connected to the CO lead to the incoming trunk circuit.

This battery shunts the trunk circuit T relay assuring its release so that a false charge condition can not be established.

RELEASE OF TERMINATING SENDER

After the terminating marker has been selected and has received the necessary information for completing the call, it connects ground to the RL lead of the terminating sender.

Terminating sender circuit RL relay operates and locks.

Due to ground being connected to the RL lead.

Battery is disconnected from the ST lead of the terminating marker connector vircuit.

Terminating sender circuit OA or OB relay releases.

Terminating sender circuit FOO or F10 relay releases.

Terminating sender circuit A1 relay releases.

Terminating sender circuit F - relay releases.

Ground is removed from the S lead, releasing the hold magnets, associated with the selected link.

Terminating sender circuit ON2 relay releases.

Receiving circuit KP relay releases.

Due to the removal of battery from the BAT 2 lead.

Terminating sender circuit TC-1 relay releases.

Terminating sender circuit TC-2 relay releases.

Terminating sender circuit TH-, H-, T-, and U- relays, and the SP relay, release in parallel.

Terminating sender circuit FT relay releases.

Terminating sender circuit ON-1 relay releases.

Receiving circuit KP-1 and KP-2 relays release.

Due to the removal of battery from the BAT 1 lead.

Terminating sender circuit SPL relay releases, if operated.

Terminating sender circuit TM-1 relay releases, if operated at this time.

Terminating sender circuit RL relay releases.

Ground is disconnected from the SB lead.

This allows the SB relay for this sender in the sender subgroup circuit, to release, making this sender available.

CHAPTER 7

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CHAPTER 7

SECTION 1

PURPOSE, DESCRIPTION AND FUNCTIONS

Terminating Marker Connector Circuit SD-25036-011

MARCH 1954

PURPOSE, DESCRIPTION, AND FUNCTIONS

GENERAL

This section covers the terminating marker connector circuit.

TERMINATING MARKER CONNECTOR

PURPOSE

The terminating marker connector circuit is used to connect terminating senders, multi-frequency sender, "B" switchboard senders, and "A" switchboard number checking senders to the terminating markers.

DESCRIPTION RM 7-1

A terminating marker connector circuit includes a maximum of five multi-contact relays for connection to senders, a minimum of three and a maximum of ten multi-contact relays for connection to terminating markers, and the associated control and alarm equipment. There are four connector circuits per connector frame, numbered 0 to 3 from the bottom up. The numbering of the connector frames, also, starts at zero.

Each terminating marker connector is arranged to serve a maximum of four terminating senders, or a maximum of five "B" switchboard senders or five "A" switchboard number checking senders. In addition, any combinations of terminating, "B" and number checking senders, totaling five circuits, may be served by the same connector, except that no more than three terminating senders may be included in such a combination.

The senders of an office are divided into a number of groups, each group of senders being wired to a connector circuit. No sender appears in more than one connector. The terminating markers, however, are multipled throughout all the connectors, so that any sender may be connected to any marker. The circuits are so arranged that only one sender multi-contact relay and one marker multi-contact relay in a particular connector can be operated at one time, and only one marker multi-contact relay belonging to a particular marker can be operated at one time.

The terminating marker connector circuits are divided into as many blocks as there are terminating markers, each block taking a different one of the markers as first choice. If that one is busy, the nearest idle one is selected, the markers being arranged in a definite order in a chain circuit.

FUNCTIONS

When a four-digit number has been registered in a multi-frequency sender, terminating sender, a "B" switchboard sender, or an "A" switchboard number checking sender, battery is connected to the start lead to the connector circuit. If the connector is idle, or after it has served waiting calls in other senders, it operates a multi-contact relay for the calling sender. This closes a number of leads between the sender and the connector. A multi-contact relay for a preferred terminating marker is then operated, closing the leads through to the marker.

By means of these leads, the marker records the number registered in the sender, the incoming frame indication and other items of information. After having completed the call, the marker sends a release signal to the sender. The sender then removes battery from the start lead to the connector circuit, releasing all operated relays in the connector. This in turn, releases the marker.

Under certain trouble conditions, the terminating marker may return a trouble release signal to the connector circuit instead of the regular release signal normally transmitted to the sender. In such a case, the connector releases the marker and connects to another one, in order to make a second trial. The sender remains connected during these operations. If there is a second trouble release signal, it is transmitted directly to the sender, causing it to restore and to release the connector.

A timing circuit in each connector gives an alarm and makes the associated senders busy in case the connector does not respond to a demand from a sender for connection with a marker, or in case such a connection when established is held for an excessive length of time. Lamps are provided to indicate the sender involved when a connector time alarm is given.

A sequence circuit provided between connectors prevents one connector which is handling a call, from starting a new call, until every other connector having a nonspecial call stored has handled one call. A special call stored in a connector does not indicate a call waiting condition to the sequence circuit. If a connector is unable to connect to a marker within a measured time, the sequence circuit is made inoperative and the connectors can function without it. The time out sounds a minor alarm which when manually released causes the sequence circuit to become operative again.

The connectors are arranged to record in the terminating trouble indicator circuit the number of the connector frame, the number of the connector on the frame, and the location of the sender in the connector, in case of a marker failure in which the trouble indicator is used.

CHAPTER 7

SECTION 2

METHOD OF OPERATION

Terminating Marker Connector Circuit SD-25035-011

MARCH 1954

METHOD OF OPERATION

SENDER PREFERENCE OS 418, 501

When a four digit number has been registered in a full selector terminating sender, multifrequency sender, "B" switchboard sender, or an "A" switchboard number checking sender, the sender connects battery to the ST lead to the connector circuit. This causes the following:

Connector circuit SS relay for the calling sender operates, and the CA-1 relay operates in series.

> Relays SS and S are provided in the connector for each sender. These relays are wired per SD Fig. 3 for the first sender, SD Fig. 4 for intermediate senders, and SD Fig. 5 for the last sender. The operating path for the SS relay is traced through normal contacts of preceding SS relays (except for the first one) or through its own normally closed make before break contact and operated contacts of the succeeding SS relay (except for the last one). This is to prevent its operation if a preceding SS relay is operated and the succeeding SS relay is normal, and is a factor in causing waiting senders to be served in rotation from the last to the first. The SS relay for the first sender can operate at any time, independently of the other relays in the chain.

The SS relay locks (except the one for the first sender) and the CA-1 relay holds, in series.

Ground is connected to the CA-1 interrupter, similar to the original marker connector circuit.

> This ground is used to start the time measure, described later, for giving an alarm if the connector circuit should fail to operate a marker multicontact relay.

Connector circuit SPL relay operates if the SPL lead has been grounded by the sender.

Ground is removed from the GL lead to the multicontact S relays.

> This removal of ground prevents this sender, while waiting for a special marker, from indicating a call waiting condition to the sequence circuit. A call waiting for a special marker is more liable to encounter a delav than one waiting for any marker. In order not to block the sequence circuit, calls for special markers cause this ground to be removed. ground to be removed.

Connector circuit CB relays for all regular markers operate.

Terminating markers Nos. 0 and 1 are "special" markers arranged for the completion of number checking calls, no-test calls, and no-hunt calls, in addition to regular calls as handled by the other markers. On these special calls, the sender will have connected ground to the SPL lead, causing the SPL relay to operate as above. There is a CB relay in each connector for each terminating marker circuit. The function of these relays, when operated, being to make the corresponding marker busy to the particular connector. The SPL relay, by operating the CB relays for all the regular markers, prevents their selection and causes one of the special markers to be used.

On regular calls, the SPL relay not being operated, any one of the regular or special markers may be selected, depending upon preference and busy conditions.

CALLS REQUIRING SPECIAL MARKERS

Listed below are the various kinds of special calls, requiring special markers, and the type of sender used to complete each call.

Kind of Call	Type of Sender Required
K.P.A. Number Check	Number Checking Sender
Toll " "	"B" Sender
L.T.D. No Test Call	"B" Sender
K.P.A. " " "	KP Sen. & FS Term. Sen.
L.T.D. Neither No Test Nor No Hunt: (Same as regular call except that special TM cancels line test.)	"B" Sender
O.G.T. No Hunt Call: (For testing subscriber's lines.)	FS Term. Sender
M.R. Rack No Hunt Call: (Used in connection with M.R. tests.)	"B" Sender

Connector circuit S relay for the calling sender operates and locks.

In order for the S relay to operate, all succeeding SS relays must be normal, as the ground is furnished at the last one through a normal contact chain. This circuit arrnagement prevents interference in case of simultaneous calls from senders causing two or more SS relays to operate. Together with the SS relay operating paths described, it insures that the senders are served in rotation from the last to the first.

The operating path of the S relay is also taken through the normal contacts of the TR relay. This insures that the TR is released between calls and prevents a false release of the terminating sender on a first trial failure.

Operation of the S relay closes the receiving, check, control, and release leads from the sender to the common wiring on the terminating marker relays TM, so that the operation of one of these relays, described below, will connect the leads to a marker.

MARKER PREFERENCE

Relays DS, CB, and TM are provided in each connector for each terminating marker to which the connector has access. These relays are wired per SD Fig. 6 for the first marker, SD Fig. 7 for intermediate markers, and SD Fig. 8 for the last one, except that in the SD Fig. 7 provided for marker No. 1 the CB lead designated "To Fig. 10C" is not furnished.

In order to reduce the number of simultaneous calls for a particular marker and to distribute the calls as evenly as possible, different connectors are given different markers as first choice.

This is accomplished by dividing the connectors into as many nearly equal parts as possible. Each connector having a block for each terminating marker. In the first or top connector, the A punching is cross connected to the B punching associated with the last terminating marker. The A punching is cross connected to the B punching associated with an intermediate marker in the intermediate marker connector. Any other intermediate marker connectors may be wired in a similar manner. The last connector has its A punching cross connected to the B punching associated with the first marker.

In addition, preference chains are provided for each marker throughout all the connectors. With respect to the connector equipment for the first marker, the D punching of each connector is cross connected to the E punching of the preceding connector except for the last connector which has its D punching connected to ground. This provides a normal contact chain for the operation of DS relays permitting any DS relay to operate if all preceding DS relays are normal and preventing the operation of a DS relay if any preceding one is already operated. The E punching of the intermediate connector (for the first marker) is connected to the DA punching, providing a path for the DA-1 relay in the marker to operate when all the DS relays for that marker are normal. There is a similar control circuit for each marker throughout all connectors.

A similar chain circuit in the opposite direction is provided for operating the TM relays by connecting the H punching of each connector to the G punching of the following connector, except for the H punching of the first connector which is wired to ground. With this circuit arrangement, in case of simultaneous operation of DS relays, only the TM relay in the higher numbered connector can operate: this circuit having the preference for the first marker. The G punching of the last connector is connected to the F punching, providing a path for the DA-2 relay in the marker to operate when all DS relays for that marker are normal.

The CKG leads between the connector circuits and the terminating markers are provided so that a connector circuit can supply a ground to the marker selected for a call. The marker CKG leads terminate at L punchings, one L punching being provided for each marker, and each L punching being common to the connector equipment for one marker in all connectors. The L punching for the first marker is connected to the J punching at the DS relay for the first marker in the first connector circuit.

The K punching of each connector is connected to the J punching of the preceding connector, except that the K punching of the last connector is left open. With this circuit arrangement, an operated DS relay connects ground through normal contacts of DS relays in following connectors, to the CKG lead to the marker.

In a similar manner chain circuits are provided for the second marker throughout all connectors, except that the start and end points are changed.

In offices having more than three terminating markers, and consequently more than three block divisions, additional chain circuits are provided.

OPERATION OF MARKER MULTICONTACT RELAY

Operation of the connector circuit S relay, previously given, causes the DS ~~multicontact~~ relay to operate. The DS relay is the one for the marker that is first choice in the calling connector if that circuit is idle, which is the assumed condition. The path to operate the DS relay is traced from battery on the ST lead from the sender, operated contacts of the S relay, normal contacts of the GT or GT-1 relays, A punching cross connected to a B punching, normal contacts of the CB relay, winding of the DS relay, and over the D-E chain to ground at the first connector of the block. If the calling connector is the first one in the block, its D punching is connected to ground and the D-E chain does not have to be used.

> There is a control circuit for each marker. The DA-1 and DA-2 relays are operated, while the marker is idle, over the D-E and G-H chains. They release due to operation of the DS relay associated with the marker in any connector. Release of these relays starts the marker time measure by connecting ground to the TM lead.
>
> The path to operate the TM relay is traced over the G-H chain to ground at the last connector of the block having the marker as last choice. This circuit arrangement prevents interference in case of simultaneous calls in different connectors for the same marker operating two or more DS relays.

Operation of the TM relay closes the receiving, check, control and release leads from the connector and, consequently from the sender, to the associated marker.

Ground is connected to the SPL lead to the terminating marker if the SPL relay is operated.

If the SPL relay is operated, a special marker will have been selected. As special markers may also be used for regular calls, the type of call must be indicated to the marker. This is accomplished by the SPL lead, grounded as above for special calls, and left open, due to the SPL relay being normal, on regular calls.

The GT and GT-1 relays will operate similar to the originating marker connector for the purpose of regulating traffic in the connectors.

Connector circuit GRA relay operates.

The GRA relay operated disconnects the RL and TRL leads from the winding of the GR relay. The GR relay is provided to give an alarm in case the RL or TR-1 lead should become falsely grounded. The GRA relay is slow operate in order to maintain the false ground test on these leads as long as possible.

The circuit functions as shown on SC 501 until the connector circuit CB relays in all connectors associated with the selected marker operate, except the one in the connector which has seized the marker.

These relays operate over individual CB leads grounded by the operated CBR and CBS relays. The CB relay in the connector which has seized the marker does not operate as it is short-circuited by the TM operated.

The operated CB relays open the paths to their associated DS relays and close them in each case to the CB and DS relays associated with the next choice marker. If any other DS relays associated with the same marker were operated, due to simultaneous calls for the marker, they release at this time.

Due to the CB relays operated, subsequent calls in connectors having the busy marker as first choice will cause a DS relay for the second choice marker to operate, if that circuit is idle. In a similar manner, any marker upon being seized and operating its CB relays in the connectors causes calls that would otherwise be routed to it make an initial attempt on the next choice circuit or the nearest idle circuit. The CB relays for the last marker extend the start leads to the equipment for the first marker.

Operated CB relays in busy connectors lock, except those in connectors in which all of the CB relays are operated.

The operated CB relays lock to prevent a connector which has started to seize a second or later choice marker from abandoning that choice and reverting to an earlier choice circuit if one becomes idle at this time. The locking paths are not effective in connectors having all their CB relays operated, as this would cause interference with waiting calls not yet connected to markers.

The sender is now closed through to the marker and the marker is made busy in all other connectors as the paths to its DS relays in these connectors are open. The connector circuit holds the connection until the marker has received the information from the sender and has completed the call. The marker then connects ground to the RL lead, closed through the connector to the sender, as a regular release signal, causing the sender to release the connector.

RELEASE OF CONNECTOR CIRCUIT

After all marker functions are complete on a regular call the sender will receive a release signal from the marker. When the sender receives a regular release signal from the marker, it removes battery from the ST lead to the connector circuit, causing the connector relays to release as shown on OS 501-1 sheet 3.

SIMULTANEOUS CALLS IN ONE CONNECTOR OS 501

Any SS relay can operate if all preceding SS relays are normal or if the succeeding SS relay is operated.

If any two or more senders within one connector connect battery to their start leads simultaneously, with no other SS relays already operated, the two or more associated SS relays can operate. For example, if the first and last senders call at the same time, the SS relay for the ~~last~~ first sender operates as in regular operation. While it is operating, the SS relay for the ~~first~~ Last sender can also operate, closing its locking path before its operating path is opened by the SS relay for the ~~last~~ first sender. Any number of SS relays within one connector can operate simultaneously.

In this case both SS relays remain operated but the only S relay that can operate is the one for the first sender, due to the ground chain through the SS relay contacts. This sender thus has preference. When the first sender releases its SS relay, the S relay for the last sender operates and that call proceeds.

The senders associated with operated SS relays are served in order from the first to the last, each SS relay in releasing closing ground for the next preceding S relay. If any senders connect battery to their start leads while a call is being served in a lower numbered sender, these senders operate their SS relays simultaneously after all senders with SS relays already operated are served and the lowest numbered operated SS relay has released. The preference then continues.

SIMULTANEOUS CALLS FOR ONE MARKER

Any DS relay for an idle marker can operate if the DS relays in all preceding connectors, up to the ground end of the D-E chain, are normal.

If two or more connectors in the same block (or temporarily included in the same block due to marker busy conditions) connect battery to their A punchings simultaneously with no other DS relays for the marker already operated, the two or more associated DS relays can operate and lock. For example, if the first and last connectors call at the same time for marker 0, the DS relay for the last connector operates and locks as in regular operation and the DS relay for the first connector simultaneously, closing its locking path before its operating path is opened by the DS relay of the last connector. Any number of DS relays for one marker can operate simultaneously.

In this case the only TM relay that can operate is the one for the first connector. The DS relay of the last connector releases when the CB relays operate, advancing the start lead.

MARKERS OTHER THAN FIRST CHOICE

When a marker becomes busy, operation of its CB relay causes all remaining idle connectors having it as first choice to be temporarily associated with their second choice markers. For example, a call in the first connector connecting to the first marker causes the last connector to be temporarily associated with the intermediate marker together with the intermediate connector. Any of these connectors calling singly seizes the intermediate marker. Simultaneous calls in these connectors operate their DS relays for the intermediate marker and the preference starts at the connector nearest the ground end of the G-H chain, as before. Under these conditions, if the intermediate marker becomes busy, all remaining idle connectors are associated with the last marker, the preference being determined as before.

If two or more connectors call simultaneously and their choices fall on differenct idle markers, all connections are made at once. If their choices fall on the same marker, the preferred connector seizes it as described above. The unsuccessful connectors connect to succeeding idle markers without appreciable delay, if there are any available, due to the CB relays in operating advancing the start leads.

If connectors call while all markers are busy, they are served as markers are freed, in regular order, depending upon the preference chains.

SECOND TRIAL OS 501 and

After the marker has completed the connection to the called line, it connects ground to the RL lead, closed through the connector to the sender, as a regular release signal. This causes the sender to release the connector.

If, however, the marker can not complete the call due to trouble, it does not send the regular release signal but times out and connects ground to the TRL lead to the connector circuit as a trouble release signal. This causes the connector to release the marker used for the first trial and connect to another one, holding the sender connected during this interval, except that if all other markers are busy the same one may be reselected.

The trouble release relays are located in the connector circuit rather than in the sender so that a different marker will be used for the second trial, if one is available, and also to prevent delay in starting the second trial, which would otherwise occur if other senders in the same connector had calls waiting which would have to be completed before the same sender could start a second time.

It is assumed that the circuit has functioned as previously described and that, due to a trouble, the marker connects ground to the TRL lead to the connector circuit. This causes the following:

> Connector circuit TR relay operates and locks.
> The TR-1 relay is short circuited.

The operating paths of the connector circuit S relays are opened.

> The operated S relay does not release at this time as it is held by its locking path. The operating paths of the S relays are opened to prevent interference in disconnection.

The CB relay for the marker used on the first trial operates. Due to its short circuit being removed.

> Operation of the CB relay for the marker used on the first trial releases the operated DS relay and causes the DS relay for the next choice of nearest choice marker, if another marker is available, to operate and lock.
>
> The DS relay operated causes its associated marker to be selected and connected to the sender as described for a regular call. Release of the DS relay for the marker used on the first trial causes the associated DA-1 and DA-2 relays to operate and the TM relay to release. Release of the TM relay releases the CBR and CBS relays, which in turn release the operated CB relays for that marker in all connectors, except those connectors that are busy on other marker calls. Release of the TM relay recycles the timing by the CA-1 interrupter.

Connector circuit TR-1 relay operates and the TR relay is locked in series. Due to the TRL lead being opened by the release of the TM relay ground is connected for short circuiting the CB relay for the selected marker. The TRL lead is closed between the marker and the sender so that a second trouble release signal, if sent, will register in the sender rather than in the connector. Ground is connected to the TR-2 lead as an indication to the marker that second trial is being made.

Under the condition described above, the CB relay for the first marker will remain locked to the operated S relay. If however, all other markers were busy, the CB relay locking circuit would be open. The release of the marker CBR and CBS relays will release the connector CB relay for the first marker. The DS relay would then reoperate and the same marker would be reused for a second trial.

The call continues from operation of the DS relay as described for a first trial, except that the TR-2 lead to the marker is grounded as a second trial indication.

If a second trouble release signal is sent, it is transmitted directly to the sender, causing it to restore and to release the connector.

In disconnection, the TR and TR-1 relays release when the S relay releases. Release of the TR relay closes the operating paths of the S relays. The start leads are wired through normal contacts of the TR relay to prevent interference in disconnection, in case other senders in the connector should have waiting calls. Otherwise, as soon as the SS relay released, the S relay of a waiting sender (having its SS relay already operated) could immediately operate. This might hold the TR and TR-1 relays falsely between calls.

CONNECTOR ALARM

TIMING FOR OPERATION OF TM RELAY

The connector time alarm circuit provides an audible alarm and indicates the sender and connector involved, if the connector circuit should fail to function properly within a certain period of time. The time measure starts when ground is connected to the CA-1 interrupter by operation of the CA-1 relay upon seizure of the connector. An additional ground is connected to the CA-1 interrupter when the S relay operates. This is to provide for alarm facilities if the CA-1 relay should fail to operate or if the S relay should fail to release. The circuit functions as follows in case of a trouble.

Due to the TRL lead being opened by the release of the TM relay, the TR-1 operates and the TR relay is locked in series. The TRL lead is closed between the marker and the sender.

> The TRL lead is closed between the marker and the sender so that a second trouble release signal, if sent, will register in the sender rather than in the connector.

Ground is also connected for short circuiting the CB relay for the selected marker as an indication that second trial is being made, ground is connected to the TR-2 lead to the marker.

Connector circuit CA-2 relay operates and locks. When the B contact of the CA-1 interrupter closes with the CA-1 relay operated.

Connector circuit CA-4 relay operates. When the F contact of the CA-1 interrupter closes with CA-2 relay operated.

> The CA-4 relay operates in from 5 to 12 seconds after the CA-1 relay operates, depending upon the position of the interrupter when the connector is seized. Ordinarily the connector circuit is released, releasing the alarm relays, before the expiration of this period of time. If the circuit is held, however, long enough to operate the CA-4 relay as above, the following takes place:

Ground is connected to the C lamp for the connector circuit.

> There is a C lamp on the trouble indicator frame for each connector circuit, used to identify the connector involved in a failure.

Ground is connected to the CT lead to the trouble indicator frame.

> Ground on the CT lead operates the CT relay (not shown) which starts the major audible alarm and lights a lamp to indicate that a connector has timed out.

Connector circuit CA-6 relay operates and locks.

An additional ground is connected to the C lamp for the connector circuit.

> Operation of the BAT key on the trouble indicator frame causes the C lamp grounded by the operated CA-4 relay to light, indicating the connector circuit that timed out. An S lamp also lights, from ground at the S relay operated, indicating the sender involved. There are five S lamps wired to all the connector circuits in common.
>
> While the BAT key is operated, C and S lamps other than the ones indicating the failure may light momentarily, due to calls going through, but the ones involved in the trouble remain lighted steadily.

A locking circuit is closed for the CA-4 relay.

TIMING FOR RELEASE OF CONNECTOR

If the connector circuit functions properly up to operation of the TM relay and consequently does not bring in the alarm as above, the first timing period is cancelled and a second one is started when the TM and CA-5 relays operate. This restart of timing permits a shorter timing interval before the connector alarm is sounded than would be possible if an over-all timing period were used. Also, the use of shorter periods with the restart serves as a check in case senders are delayed in engaging a marker.

When the TM relay operates, it operates the CA-5 relay and connects ground to the CA-2 interrupter. The CA-5 relay operated removes ground from the CA-1 interrupter and releases the CA-2 relay, if operated, thus cancelling the first timing period. The CA-5 relay also connects ground to the C lamp. The circuit functions as follows in case of a trouble in this stage.

Connector circuit CA-5 relay operates and locks. When the B contact of the CA-2 interrupter closes with the TM relay operated.

Connector circuit CA-4 relay operates and locks. When the F contact of the CA-2 interrupter closes with the CA-3 relay operated.

> The CA-4 relay operates in from 5 to 12 seconds after the TM relay operates. Ordinarily the connector circuit is released, releasing the alarm relays, before the expiration of this period of time. If the circuit is

held, however, long enough to operate the CA-4 relay as above, ground is connected to the CT lead for sounding the alarm. The identity of the connector and sender involved is shown as before when the BAT key is operated.

If no trouble is encountered during the call, the time measure ends when the TM relay releases, removing ground from the CA-2 interrupter and releasing the CA-3 relay, if operated.

TEST FOR FALSE GROUND ON RL AND TRL LEADS

If the RL lead, or the TRL lead wired to the connector circuit S relays, should become falsely grounded in the connector circuit, senders would repeatedly be dismissed prematurely. The GR relay is provided to bring in an alarm in this case. A ground on either of these leads before the marker is engaged causes the GR relay to operate.

The GR relay locks to ground at the RLA key at the trouble indicator frame and lights the GR lamp at the trouble indicator frame. As described for the CA-4 relay, it also connects ground to the CT and C leads to provide an alarm and indicate the connector in trouble.

Momentary operation of the RLA key releases the GR relay which extinguishes the GR lamp and removes ground from the CT and C leads.

Operation of the GRA relay when the TM relay operates, in a regular call, disconnects the RL and TRL leads from the GR relay, to prevent bringing in the alarm when a release signal is sent from the marker. The GRA relay is slow operate in order to maintain the false ground test as long as possible.

If the TRL lead wired to the TM relays should become falsely grounded with the circuit normal, the connector circuit TR relay would operate. This would open the operating paths for the S relays. On the next call from a sender, an SS relay and the CA-1 relay would operate, but the call would not progress beyond this point. The CA-1 relay operated, however, would bring in the connector time alarm.

CONNECTOR TRAFFIC SEQUENCE REGULATOR RM 7-2

In periods of heavy traffic when all markers are not in service, connectors may be delayed in seizing markers. In order to equalize these delays between the various connectors and prevent any connector from having extreme delays, a traffic connector regulating feature is provided. Otherwise some connectors having comparatively slow operating DS relays might be delayed for seconds while other connectors seized markers quickly.

The method used for regulating is to lock out of service any connector which has seized a marker until all other waiting connectors have each served one call. This is accomplished by gate relays GT and GT-1.

When a call enters a marker and succeeds in operating a TM relay the GT and GT-1 relays associated with the connector operate. When the sender releases the Connector the TM relay releases and removes the operating ground for the GT relay. Now, if some other connectors are waiting for a marker their S relays are operated, which provides a locking circuit for all connector GT relays operated.

The locking circuit for the GT relay is from battery in the terminating trouble indicator circuit over the BO or BE lead, break contacts CA-6, secondary winding of GT, make contacts GT-1 and GT, common strap lead CP to all connectors which are waiting for markers, break contacts of their GT and GT-1 relays, over GT lead to make contacts of the S relay.

As long as a GT relay remains operated, the path from the start lead to the A punching remains open, so that its connector will not reseize a marker until all GT relays in waiting connectors have been operated, at which time all GT relays are unlocked. The GT relays in connectors which are not serving calls at the moment then release, in turn releasing their GT-1 relays. Now if any one of these connectors has a new call waiting, it connects locking ground to the common strap lead CP through the back contacts of the GT-1 relay. Relay GT-1 is therefore made a little slow release in order to permit all GT relays to release.

The operation of the relay opens the operating circuit of relay DS, but the DS relay has a holding circuit independent of the GT relay from the TM relay until the sender opens the start lead.

The sequence circuit becomes inoperative if a TM relay fails to operate and causes a timeout. The operation of the CA-6 relay opens the operating battery path for the GT relay causing it to release. The circuit also becomes inoperative if the GT is operated, preventing the connector from serving any other calls, because some other connector is grounding the CP lead and that connector is unable to complete its call even though a marker is available. Under those circumstances, the GT lead to the terminating markers is grounded and providing one or more of the markers are available for between 2 to 5 seconds, a timing circuit on the terminating trouble indicator causes battery to be removed from the BO or BE leads in turn releasing the GT relay. This protection must be provided in order to prevent certain types of trouble in one connector causing all the other connectors' GT relays to lock up and completely block the starting of any calls.

Either of these failures lights the TFA lamp on the terminating trouble indicator as a signal that the sequence circuit is inoperative. It is necessary to operate the LORL key on the trouble indicator to restore the sequence circuit to operation.

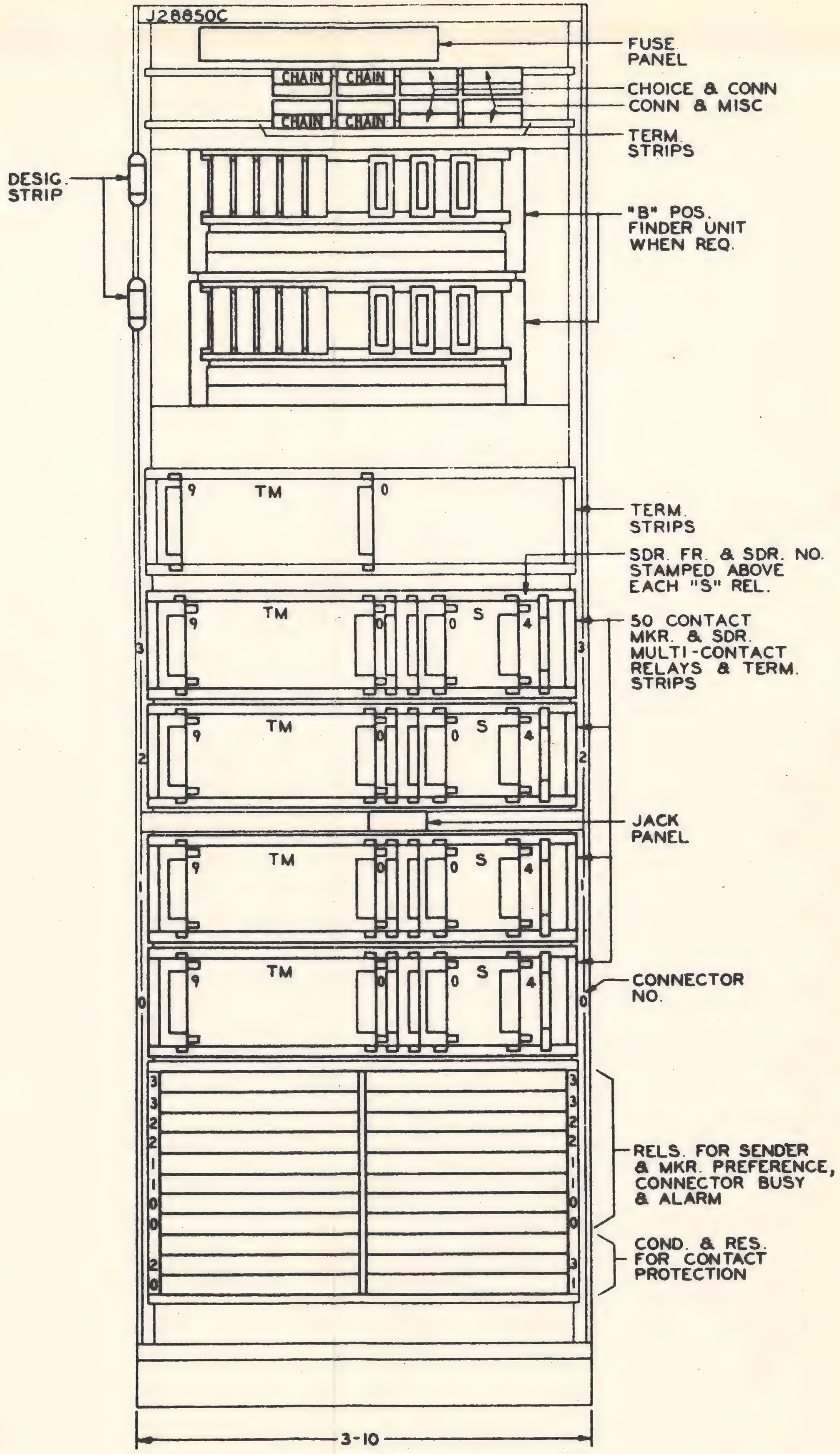
TERMINATING MARKER MAKE BUSY OS 526

A terminating marker may be made busy at all connectors by the insertion of a short-circuited plug in the DB jack for the marker, this jack being located on the trouble indicator frame. This operates, in turn, the DB relay, the CBR and CBS relays, and all associated CB relays. The DB relay opens the DB lead to the marker, to prevent a time alarm.

A marker may be made busy at a single connector by means of a CB jack, also located on the trouble indicator frame. One of these jacks is provided for each appearance of each marker in the connectors.

MARKER TIME ALARM

Any trouble which ties up the marker connector will give the connector time alarm, and if it also ties up a marker it will also give the marker time alarm. If a marker alone is tied up, as by a false ground on the DB lead relay, the marker alarm only will be given.


J28850C
FUSE PANEL
CHAIN
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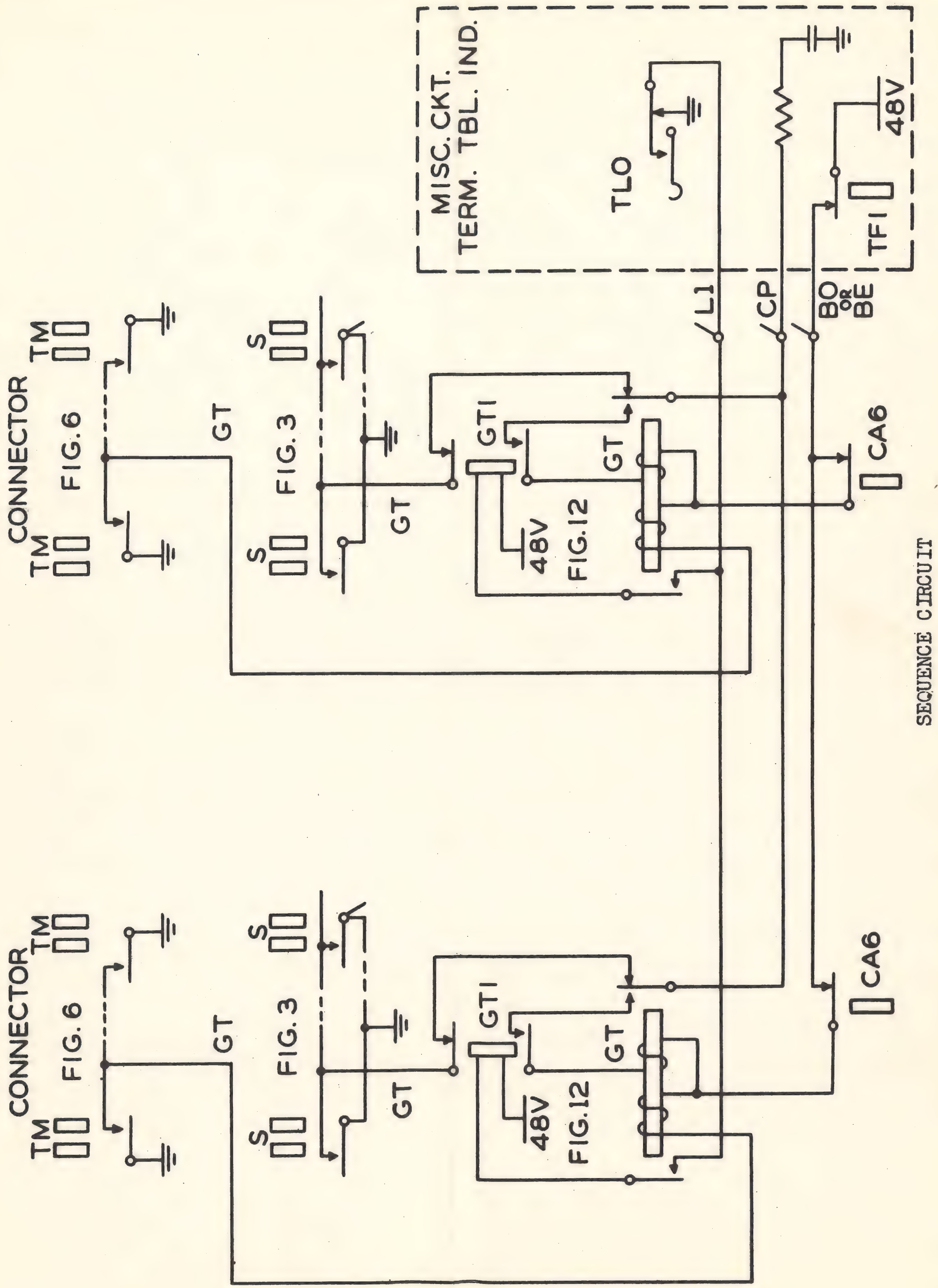
CHAIN
CHAIN
CHOICE & CONN
CONN & MISC
TERM. STRIPS
DESIG. STRIP
"B" POS. FINDER UNIT WHEN REQ.
TM
9
0
TERM. STRIPS
SDR. FR. & SDR. NO. STAMPED ABOVE EACH "S" REL.
S
4
3
2
1
50 CONTACT MKR. & SDR. MULTI-CONTACT RELAYS & TERM. STRIPS
JACK PANEL
CONNECTOR NO.
RELS. FOR SENDER & MKR. PREFERENCE, CONNECTOR BUSY & ALARM
COND. & RES. FOR CONTACT PROTECTION
3-10

Marker Connector Frame



SEQUENCE CIRCUIT

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CHAPTER 8

SECTION 1

PURPOSE, DESCRIPTION AND FUNCTIONS

Terminating Marker Circuit	SD-25283-01, Issue 47D
Number Group Connector Circuit	SD-25276-01, Issue 19D
160 Incoming Link and Connector Circuit	SD-25457-01, Issue 12D
100 Incoming Link and Connector Circuit	SD-25032-01, Issue 22D
Line Choice Connector Circuit	SD-25275-01, Issue 18D

MARCH 1954

PURPOSE, DESCRIPTION AND FUNCTIONS

GENERAL

This section covers the terminating marker and its associated circuits. The associated circuits are those used by the terminating marker in setting up a connection from the ~~from the~~ incoming link to the called subscriber on the line link frame.

PURPOSE

The terminating marker circuit is used for translating the called line number received from a terminating full selector multifrequency or "B" switchboard sender into numerical blocks, and together with its associated circuits, to test, select and close a path to the called line from the incoming trunk, through the incoming link and line link frames. The number group connector circuit and the line choice connector circuit are used with the marker in testing the line and closing the channel. The incoming link and line link frames and the line junctors which connect them, provide means for connecting any incoming trunk circuit to any subscriber's line. Two of the terminating markers are arranged to complete special calls from number checking, no test and no hunt trunks.

DESCRIPTION OF EQUIPMENT

TERMINATING MARKER FRAME RM 8-1, 508

There are from three to ten terminating markers in a central office. Each terminating marker is mounted on a frame consisting of two bays in which are located the relay equipment and terminal strips required for the circuit.

The terminating markers are wired for a maximum of 20 terminating marker connectors or 100 senders. The markers can be used with a maximum of 20 incoming link and connector frames and 80 line link frames.

NUMBER GROUP CONNECTOR RM 8-2

The number group connector frame is a two-bay structure arranged for multi-contact relays and terminal strips. Four number group connectors are mounted on each number group connector frame. Each connector consists of four multi-contact relays per marker which are required to connect the necessary leads between the marker and the block relay frame or frames. The frame illustrated has a capacity of ten terminating markers; but, if necessary, a frame having a capacity of six terminating markers may be furnished.

The switchboard cables from the various terminating markers are connected to the two rows of terminal strips at the top of the number group connector frame. These leads are then multipled vertically to the corresponding relays for each marker in various number group connectors. The common or strapping side of the multicontact relays is wired in switchboard cable to the proper block relay frames.

The marker is arranged to serve a maximum of 25 number group connector circuits per office unit of 10,000 directory numbers. In addition, there may be a maximum of 100 extra (X) or unnumbered numbers per number group.

The number group connector is arranged to permit only one marker to be connected to the number group at a time.

BLOCK RELAY RM 8-3 & 509

The block relay frame is a one-bay structure equipped with multicontact relays and marker type terminal strips for cross-connections. This frame accommodates the block relays and terminal strip equipment required for 800 subscribers numbers. Where a number group consists of more than 800 numbers, it is spread over more than one block relay frame. If the number group is less than 800 numbers, several number groups may be on the same block relay frame; however, the maximum is four number groups per block relay frame. Associated with a block of 100 numbers is a "hundred block" relay (~~1/2 of a multicontact relay~~). Thus, each block relay frame is equipped with eight (HB0 to 7) hundred block relays. Since each block relay frame accommodates 800 subscriber numbers, a central office unit of 10,000 directory numbers will require thirteen block relay frames. The following chart shows the subscriber hundreds number and the particular hundred block and block relay frame on which it appears. The (HB) relay can covers are designated according to the hundreds number of the subscriber's line numbers they serve.

Hundreds Block	0HB	1HB	2HB	3HB	4HB	5HB	6HB	7HB
Block Relay Frame No.	Hundreds Numbers							
0	00	01	02	03	04	05	06	07
1	08	09	10	11	12	13	14	15
2	16	17	18	19	20	21	22	23
3	24	25	26	27	28	29	30	31
4	32	33	34	35	36	37	38	39
5	40	41	42	43	44	45	46	47
6	48	49	50	51	52	53	54	55
7	56	57	58	59	60	61	62	63
8	64	65	66	67	68	69	70	71
9	72	73	74	75	76	77	78	79
10	80	81	82	83	84	85	86	87
11	88	89	90	91	92	93	94	95
12	96	97	98	99	X00	X01	X02	X03

Note: X04 to X24 are similarly arranged on frames 13 to 15.

If a partial unit is installed, such block relay frames as are required, based on directory numbers, will be equipped in accordance with the above table.

Each (HB) hundred block relay is associated with five (TB) "twenty block" relays, each of which is associated with 20 subscribers' numbers. The (TB) twenty block relays are designated 00-19, 20-39, 40-59, 60-79, 80-99, according to the 20 numbers of the 100 numbers it serves.

Mounted to the left of the (HB) hundred block relays are (XG) relays associated with each number group which is connected to this particular block relay frame. These (XG) relays are used on number checking calls.

The lower half of the block relay frame mounts terminal strips designated NF, HF, XF, TF, RF, NC, and HG, as illustrated in RM 511. These terminal strips are used for cross-connections wherein leads associated with each subscriber's number are cross-connected to return pertinent information to the terminating marker.

NF PUNCHINGS

There are 800 NF punchings on each block relay frame. These punchings originate at the contacts of the 40 twenty-block relays and are numbered to agree with the numbering of the associated twenty-block relays. The NF punchings appear on two terminal strips, one located at the top of the bay of terminal strips and the other located at the center of the bay just below the RF terminal strip.

The units digit designation appears at the left of the punching. The 0 to 4 units digit appears on the lower terminal strip, whereas the 5 to 9 units digit appears on the upper strip. The tens digit designation appears above the punching (upper strip) or below the punching (lower strip).

If a directory number is 0478, the NF punching appears in the upper terminal strip.

HF PUNCHINGS

The HF terminal strip is located directly below the upper NF terminal strip. The punchings are numbered 0 to 19 vertically and represent the line choices in a maximum office. Where there are less than ten line choices, these terminals have duplicate appearances.

If 200 or more numbers are in a number group, two or more sections of HF terminal strips are strapped horizontally, thereby permitting most of the jumpers to be run vertically. RM 511 shows 0000 to 0399 associated with number group 0 and 0400 to 0799 associated with number group 1.

XF AND TF PUNCHINGS

These punchings appear on a strip located directly below the HF punching strip and are arranged in the same manner as the HF punchings described above; if the XF punchings are used, the TF (10-19) are beside the TF (0-9), rather than above. The XF punchings in this case appear directly above the TF punchings. The numbers 0 to 19 correspond to the line choice numbers, as do the numbers for the HF punchings; but, where there are less than ten line choices, the TF punchings are multipled straight across. The XF field is similar to the TF and should be multipled in the same manner.

RF PUNCHINGS

The RF terminal strip is located directly below the TF terminal strip and is similar to the HF terminal strip. The 0 to 19 count in this case also represents the line choice numbers.

NC PUNCHINGS

There are 800 NC punchings on each block relay frame, and they are similar to the NF punchings previously described. The NC punchings originate at the contacts of 40, twenty block relays and are numbered to agree with the numbering of the associated twenty block relays. The NC punchings appear on terminal strips located in two sections, one located immediately above the HG terminal strip, and one located below. The punchings are numbered in the same manner as the NF punchings previously described.

HG PUNCHINGS

The HG terminal strips are located between the upper and lower NC terminal strips. The terminal strips are the same as the HF strips except that there are two of them, thereby providing 40 vertical punchings rather than 20. The designations 0 to 9 indicate the horizontal group of switches of the line link, and the letters A to D indicate the frame in the choice. Where there are more than 200 numbers in a number group, the sections of HG terminal strips are strapped horizontally in the same manner as the HF terminal strips previously described.

JF PUNCHINGS

There are two strips of JF punchings, one located to the right of the HF terminal and one to the right of the RF terminal strip. There are twenty punchings vertically in each terminal strip making forty punchings available in the two strips. The JF terminal are numbered 0 to 4 vertically and correspond to 0 to 4 twenty block relays. Where there are fewer number groups, the terminals should be multipled to provide a greater number of solder points.

JC PUNCHINGS

The JC punchings are located at the right side of both HG terminal strips. There are 20 punchings vertically on each terminal strip making 40 punchings available. The terminals are numbered 0 to 18 vertically in steps of two allowing for four number groups. Where there are fewer number groups, the terminal strips should be multipled and provide a greater number of soldering points.

ALF AND ANF PUNCHINGS - AUXILIARY TERMINAL STRIP

The ALF and ANF punchings are located on the AUX terminal strip which is located at the right-hand end of the NF terminal strip. The punchings are numbered the same as the NF punchings.

The following chart shows the subscriber numbers and their associated number group and block relay frames as they would be for a two-unit installation of 2500 numbers per number group.

Subscriber Numbers	Block Relay Frame No.		Number Group No.	Number Group Frame No.		Numbers Per No. Group
0000 to 0799	0	100	0	0	100	
0800 to 1599	1	101	0	0	100	
1600 to 2399	2	102	0	0	100	
2400 to 2499	3	103	0	0	100	2500
2500 to 3199	3	103	1	0	100	
3200 to 3999	4	104	1	0	100	
4000 to 4799	5	105	1	0	100	
4800 to 4999	6	106	1	0	100	2500
5000 to 5599	6	106	2	0	100	
5600 to 6399	7	107	2	0	100	
6400 to 7199	8	108	2	0	100	
7200 to 7499	9	109	2	0	100	2500
7500 to 7999	9	109	3	0	100	
8000 to 8799	10	110	3	0	100	
8800 to 9599	11	111	3	0	100	
9600 to 9999	12	112	3	0	100	2500

INCOMING LINK AND CONNECTOR FRAME RM 8-4, 8-5 & 510

FOR 100 INCOMING TRUNK CAPACITY

The equipment for the incoming link and connector frame consists essentially of a primary and a secondary group of 10 switches each, and marker connector relays. The switches are 200 point 3-wire crossbar switches. In offices having 10 or less incoming frames and 40 or less line link frames, the strapping of the secondary switch horizontals is cut at the midpoint to provide a left group and a right group of links.

If there are more than 10 incoming frames in an office, or if there are more than 40 line link frames, or if both of these conditions exist, the secondary horizontal multiple is not cut as above, and an "extension" frame is provided for each incoming frame. The extension frame is essentially a supplementary secondary bay of 10 switches similar to the secondary switches of the incoming link frame. When extension frames are required, the links connected to the left halves of the primary switches terminate at the nonsplit horizontal multiple of the incoming link secondary switches, and the links connected to the right halves of the primary switches terminate at the nonsplit horizontal multiple of the associated extension switches.

An incoming link frame is always used in conjunction with an incoming trunk frame and a terminating sender link frame. The corresponding frames of these three types are always located in the same line-up, with the sender link frame at the left, the incoming trunk frame in the middle, and the incoming link frame at the right, when viewed from the front. Extension frames, when provided, are located adjacent to and to the right of their corresponding incoming link frames.

The one hundred incoming trunk circuits of an incoming trunk frame are connected to the nonsplit primary switch horizontals of a corresponding adjacent incoming link frame by means of three individual leads designated tip, ring and sleeve.

Incoming links consist of three wires (tip, ring and sleeve) connecting the primary switch verticals to secondary switch horizontals, or to extension switch horizontals. There are 200 links per frame, having access in the primary bay to 100 incoming trunks, as described above, and in the secondary bay, or in the secondary and extension bays, to 200 or 400 line junctors. An incoming link frame can be used with a maximum of ten terminating markers.

The wiring of the incoming links is such that primary switch and vertical numbers, for both the left and the right links, become horizontal and switch numbers, respectively, at the secondary switches, or at the extension switches.

Line junctors consist of three wires (tip, ring and sleeve) connecting the verticals of the incoming link secondary switches, or extension switches, to verticals in the left halves of the line link secondary switches. Line junctors are multipled at two line link frames and can be used with either frame of the two. The incoming frame end of the line junctors may also be multipled, as described later.

In addition to the incoming trunk terminations, the incoming links, and the line junctor terminations described above, the incoming link and connector frame includes relays wired in a double transfer chain for preventing the simultaneous connection of two markers to the frame, and multicontact connector relays for closing the necessary control and test leads to the markers.

FOR 160 INCOMING TRUNK CAPACITY

Except for the information that follows under this caption, the 160 trunk incoming link frame is the same and related to a crossbar office as explained for the 100 trunk incoming link frame.

The primary switches are 200 point 6-wire crossbar switches. Each switch will accommodate 8 pairs of trunks on the upper eight levels 2 to 9, or a total of 16 trunks per switch. The operation of a crosspoint on any level connects the associated pair of trunks to the multiple strips of the particular vertical involved, from which one or the other of the trunks is extended to a link at the differentiating levels, 0 and 1. The differentiating levels 0 and 1 are controlled by the left or right trunks respectively operating the 0 or 1 primary select magnet. This provides a means of selecting any one trunk of the maximum of 160 which may be assigned to a particular frame. The distribution of trunks to the 10 incoming primary switches is on the basis of trunk groups at the terminating sender link frame.

LINE CHOICE CONNECTOR FRAME RM 8-6 & 8-7

The line link frames of an office are grouped into "line choices." A line choice is an association of four line link frames (line groups) which the terminating marker treats as a unit in setting up connections from incoming link frames to subscriber's lines. A line choice connector circuit is provided for each line choice, two of these circuits being mounted on a line choice connector frame. As the maximum number of line link frames in an office is 80, the maximum number of line choices and line choice connector circuits is 20.

Each line choice connector circuit includes three multicontact relays per marker for connecting a number of leads from the markers to the "line junctor connector frame," described below, and to the line link frames of the line choice. It also includes a marker preference relay circuit for preventing the simultaneous connection of two markers to the circuit.

The leads which the line choice connector circuit closes through from the marker to the line link frames are effective only with respect to the frame containing the called line. They are used for momentarily locking out originating calls, and to enable the marker to operate the proper line link horizontal group relays and hold magnets.

As previously described, the directory numbers in a number group are arranged in numerical order, except for certain special cases given later. On line link frames, however, the numbers are in terms of equipment locations and do not necessarily have to be in consecutive order. In the case of PBX groups the equipment locations are purposely selected over as many line choices as possible. This is done to increase the probability of selecting an idle channel to the called line in case of temporary channels busy at certain line link frames. It also reduces service reaction in case of line link frame failures.

Associated with each line choice connector circuit but mounted on the associated line junctor connector frame are multicontact relays used for closing two sets of leads between the line choice connector circuit and the line link frames. These leads enable the marker to test the sleeves of the line junctors and the sleeves of the line links in selecting a channel.

LINE JUNCTOR CONNECTOR FRAME RM 8-8

The line junctor connector frame mounts the multicontact relays used for connecting the sleeves of the line junctors and the sleeves of the line links between the line choice connector circuits and the line link frames. The line junctor connector frame has a capacity of four sets of connector relays, one set being associated with one line choice connector circuit and the four corresponding line link frames. RM 8-4

LINE JUNCTOR DISTRIBUTION RM 513 & 514, 511, 512

The paths between incoming link secondary switch verticals and the line link secondary switch verticals are known as line junctors. The terminating traffic between incoming link frames and line link frames is routed in accordance with two distinct plans, each of which must enable all incoming link frames to reach all line link frames. The first plan provides 200 incoming secondary verticals or line junctors per incoming link frame, and the second plan provides 400 incoming secondary verticals or line junctors per incoming group (two incoming link frames per group).

Since each incoming link frame is associated with 100 incoming trunks, the traffic load to be carried by each incoming link frame is approximately 2000 ccs. These 100 incoming trunks have 200 outlets which must be distributed evenly to all line link frames. Each line link frame has 100 line links which will carry 1000 ccs. Assuming that originating and terminating traffic is divided equally, the terminating traffic per line link frame will be 500 ccs. Therefore, each incoming link frame can handle as much terminating traffic as four line link frames. For terminating traffic, the four line link frames are referred to as a "line choice." However, the four line link frames have 400 verticals which may be used for incoming traffic, 100 on each secondary bay. There are 200 line junctors to be terminated on the secondary verticals of the line link frames. Each line choice is, therefore, divided into two half choices ("A" and "B") by multipling the 100 verticals on the secondary bays of two line link frames together. Each half choice (two line link frames) uses 100 line junctors in common from the incoming frames. There should not be less than ten line junctors per incoming link per half choice in any case.

Since there must be a minimum of ten line junctors from each incoming link frame to each half choice, the 200 line junctors of each incoming link frame will provide these ten paths to only twenty half choices or ten line choices. Similarly, the 400 line junctors of each incoming link group (two incoming link frames) will provide these ten paths to forty half choices or twenty line choices.

It will be noted that Plan 1 provides for a maximum of only ten line choices (20 half choices or 40 line link frames), having 2000 line junctors, thus a maximum of ten incoming link frames. Plan 2, however, provides for a maximum of twenty line choices (40 half choices or 80 line link frames) having 4000 line junctors; thus, a maximum of twenty incoming link frames (10 incoming frame groups).

When the ultimate size of the office will exceed the capacity of either ten incoming link frames or 10 line choices, Plan 2 must be used on the initial installation, even though the initial frame requirements are within the scope of Plan 1.

RM 511 shows, in schematic form, the manner in which the line junctors are run, using Plan 1, when the maximum of ten incoming link frames and ten line choices are equipped. This sketch shows only one switch on each frame, but like numbered switches on both incoming and line link frames are connected together in the same manner. It will be noted that all left incoming link secondary verticals 0 go to half choice 0-A. The left 0 verticals on incoming link frame 0 are connected to the 0 verticals of the line link secondary switches in half choice 0-A; the left 0 verticals on incoming link frame 1 are connected to the 1 verticals of half choice 0-A. The distribution of other junctors can be traced in this manner, the incoming link vertical number being the same as the choice number and the incoming frame number the same as the line link vertical. The right incoming link verticals connect to half choices "B" in the same manner. When less than the maximum of ten incoming link frames or ten line choices are equipped, incoming link verticals from 0 up to the number of equipped frames are connected in the regular manner as shown on RM 511. Higher numbered verticals are connected in a variable manner in accordance with standard charts for each type of installation in single steps of two to ten incoming link frames. RM 513 and 514 show these typical charts.

When less than ten incoming link frames are equipped, the number of junctors from each incoming link frame to each half choice is as follows:

No. of Incoming Link Frames	No. of Half Choices	No. of Junctors Per Inc. Link Per Half Choice
2	4	50
3	6	33 or 34
4	8	25
5	10	20
6	12	16 or 17
7	14	14 or 15
8	16	12 or 13
9	18	11 or 12
10	20	10

On a terminating call, these junctors between incoming frames and line link frames are tested by the terminating marker, ten junctors at one time. The junctor groups indicated above must, therefore, be split into junctor subgroups of ten or less. In the case of a three incoming link frame size, the junctors are split into three subgroups of ten and one subgroup of three or four.

The ten line junctors in each subgroup are connected into the terminating marker through a line junctor relay on the line junctor connector frame. There are ten line junctor relays per half choice on each line junctor connector frame, each relay cutting in for test ten of the line junctors from that half choice. Thus, the 100 line junctors to a line half choice are cut through the contacts of ten relays. Accordingly, therefore, on a job requiring three incoming link frames, calls from incoming link frame 0 to half choice 0-A can be completed over one of 33 paths which are tested by the marker 10-10-10 and 3 until an idle path is found.

Plan 2 uses a multiple arrangement of two incoming link frames and their two associated extension frames which have access to a common group of 400 line junctors; this is called an incoming group. RM 512 shows in schematic form the manner in which the line junctors are run when the maximum of ten incoming groups and twenty line choices are furnished. It will be noted that the junctors from the pairs of regular incoming link frames are run to half choices "A", and those from the pairs of extension frames are run to the half choices "B". When less than the maximum of ten incoming link groups or twenty line choices are equipped, verticals from 0 up to the number of equipped frames are connected in a regular manner as shown on RM 512. Higher numbered verticals are connected in a variable manner in accordance with standard charts for each type of installation in steps of one group from two to ten incoming groups.

This plan of distribution is similar to that used for the previous plan where the line junctors from left half incoming link secondary switches were run to "A" half choices and those from right half switches to "B" half choices. It is only necessary to visualize the regular secondary switches (with 20 verticals) as corresponding in the second plan to the left half secondary switches (with only ten verticals) in the first plan and the extension secondary switches as corresponding to the right half secondary switches. The general plan of distribution is the same except that the number of verticals, and the number of half choices is double that of the previous plan.

When ten incoming groups and twenty line choices are equipped, there are exactly ten line junctors from each incoming group to each half choice. When less than ten incoming groups are equipped, the number of junctors from an incoming link frame to each half choice is as follows:

No. of Incoming Groups	No. of Half Choices	No. of Junctors per Inc. Group per Half Choices
2	8	50
3	12	33 or 34
4	16	25
5	20	20
6	24	16 or 17
7	28	14 or 15
8	32	12 or 13
9	36	11 or 12
10	40	10

LINE JUNCTOR GROUPING FRAME

The addition of incoming link frames and line link frames to an existing installation requires a change in the line junctor distribution. To facilitate changes of this kind, a line junctor grouping frame is provided, at which the necessary connections are made for closing the line junctors as required between the incoming and line link frames.

From the above, it is evident that as an office grows toward the maximum, the addition of the incoming link frames and line link frames requires a change in the line junctor distribution. To facilitate changes of this kind, a line junctor grouping frame is provided, at which cables from the incoming secondary (or secondary and extension) switches are run vertically and connected to terminal strips on the front of the frame, and cables from the left halves of the line link secondary switches are run horizontally and connected to opposite ends of the terminal strips on the rear of the frame. Where cable leads on the front of the frame and cable leads on the rear of the frame terminate on opposite ends of the same terminal, this becomes a permanent connection and is never changed as the office grows.

Where there is less than a maximum number of incoming link or line link frames installed, there will be terminals on each side of the grouping frames which have cable leads attached to one end but not to the opposite end. These terminals are connected by jumpers. When an addition of link frames is made, and therefore additional cable is run to the front or rear (or both) of the grouping frame, there will be an increasing number of terminals having cable leads terminating on each end, and therefore some of the jumpers previously installed will be removed.

The line junctor grouping frame consists of one bay if the ultimate requirement of the office does not include incoming extension frames; otherwise it consists of two bays.

MAIN DISTRIBUTING FRAME RM 8-9

The main distributing frame is a two-sided cross connecting frame having terminal strips mounted vertically on one side and terminal strips mounted horizontally on the other side. It is arranged for cross-connecting the tip and ring leads of subscriber's lines to the tip and ring leads of the line link primary vertical equipment.

A subscriber's line tip and ring enters the central office at the vertical side of the MDF, in a cable and pair designation. The tip and ring leads (of the group T, R, S and M) of the primary switch verticals of the line link frames are cabled to the horizontal side of the MDF, and designated in column, switch and vertical. These two points are cross-connected to supply battery and ground to an MR subscriber's line. Battery is supplied by an L relay to the ring and ground to the tip, both being wired through normal contacts of the primary switch vertical hold magnet as a cutoff point for this signaling current.

Each line link column has a maximum of 100 verticals which are terminated on two terminal strips on the horizontal side of the MDF, and are designated 00 to 99 with the column number. The tens digit of the 00 to 99 numbers represents the primary switch number and the units the primary switch vertical number.

LINE DISTRIBUTING FRAME RM 8-9, 1-39 and 515

The line distributing frame is a single sided cross-connecting frame having terminal strips mounted horizontally in the upper part and terminal strips mounted vertically in the lower part. It is arranged for cross-connecting the sleeve and message register leads of the line link primary switch vertical equipment to the sleeve and register leads of the directory numbers or coded numbers.

The S and M leads (of the group T, R, S and M) of the primary switch verticals of the line link frames are cabled to the horizontal blocks of the LDF, and designated in column, switch and vertical. These designations are a duplication of the numbering on the horizontal side of the MDF, as already described under "Main Distributing Frame." This is because the T and R leads at the HMDF, and the S and M leads at the HLDF, are both associated with the same line link vertical equipment.

On the vertical blocks of the LDF the S and M leads are designated in numerical order according to the directory numbers and the coded numbers that are equipped for the central office. The S lead and the M lead on the VLDF, are cabled to two different points. The S lead is cabled to the block relay frame where it is associated with a twenty-block relay contact for indicating when a line link vertical is busy to terminating calls. The M lead is cabled to the message register rack, a register being permanently connected to each line number.

With this arrangement 2-wire cross-connections are used for connecting numbered and coded line locations and correspondingly numbered message registers at the vertical strips to line link verticals at the horizontal strips, and together with tip and ring cross-connections at the main distributing frame, provide means for assigning a line to any line link vertical.

The line distributing frame is designed to be located parallel to and facing the same frame aisle as the block relay frame. The length of these two frames is approximately the same. The groups of 800 circuits terminating on each four verticals of the line distributing frame are cabled to successive bays of the block relay frame.

FUNCTIONS RM 012 & 013

When a full selector, multifrequency, or "B" switchboard sender has registered the four numerical digits of a called line number, it connects to a terminating marker through a terminating marker connector circuit. The terminating marker receives and records the number registered in the sender, the number of the incoming link and connector frame at which the incoming trunk involved in the call appears, and other items of information.

The digits of the called line number, as registered in the marker, are translated into terms of numerical blocks. A five hundred block indication, together with a one hundred block indication, derived in this manner, cause the marker to connect battery to the start lead of the number group connector circuit for the number group in which the block of 100 numbers is located.

A twenty block indication, also recorded at this time, is used later to enable the number group connector circuit to select the twenty block, within the hundred block determined as above, which contains the called line.

Selection of the number group connector circuit causes it to lock out other markers and to indicate its availability for the call by returning ground to operate a check relay in the marker which selected it. It also operates its multicontact connector relays and the required hundred block relay on the block relay frame.

Upon reception of the check signal from the number group connector circuit, the marker connects battery to the start lead to the incoming link and connector frame on which the incoming trunk involved in the call appears. The identity of this frame, of the maximum of 20 such frames, is determined from the incoming frame registration received by the marker from the sender.

Selection of the incoming frame causes it to lock out other markers, to return a check signal as described for the number group connector circuit, to operate a multicontact marker connector relay, and to operate a relay in the calling incoming trunk circuit. Upon operation of this relay, the trunk circuit operates a relay on the incoming link frame which connects the sleeve leads of the incoming links available to the trunk to the marker.

After certain cross-tests on leads between the marker and the number group connector have been made, the required twenty block relay on the block relay frame is operated, under control of the number group connector circuit and the marker. This relay connects three leads for each of the 20 numbers to the marker, through contacts of the operated multicontact connector relays in the number group connector circuit. On a call to a direct line, or to an idle terminal hunting line, the marker makes use of the indications provided by these leads for the called number only, and disregards those for the remaining 19 numbers in the twenty block.

One of the three leads connected to the marker by the operated twenty block relay is cross-connected at the line distributing frame to the sleeve lead of the line link primary vertical assigned to the directory number. Upon operation of the twenty block relay, the marker tests this lead to determine whether the line is busy or idle.

The other two leads associated with the number are cross-connected at the block relay frame to provide information as to the type and location of the line. One of them indicates to the marker the type of line (direct, party or terminal hunting) and the number of the line choice in which the primary vertical for the called line is contained. The other indicates its location by quarter-choice (line link frame) and horizontal group.

After having received this information and provided that the called line is idle, the marker connects battery to the start lead to the required line choice connector circuit. This causes the line choice connector circuit to lock out other markers, to return a check signal, and to operate its multicontact marker connector relays. With these relays operated, the required line junctor connector relays (on the line junctor connector frame) are operated by the marker, and the line link horizontal group in which the called line is located is selected, of the 40 such groups in the four line link frames of the line choice. Operation of the line junctor connector relays connects the sleeves of the available line junctors and line links to the marker for test.

With the sleeves of the incoming links, line junctors and line links connected for test, the marker proceeds to test for and select an idle channel. A channel for connecting an incoming trunk to a line consists of an incoming link, a line junctor to which the incoming link has access, and a line link to which the line junctor has access.

After the selection of a channel the select magnets of the selected incoming and line links are operated. On line link frames having two or more bays of primary switches, corresponding primary select magnets are multipled and operated in parallel.

The incoming link sleeve and the line link sleeve are tested for false grounds, after which the incoming link primary and secondary hold magnets and the line link secondary hold magnet are operated.

Operation of the hold magnets and the consequent closure of the crosspoints closes the talking connection from the incoming trunk circuit up to the primary line switch vertical. The marker then tests this part of the connection for the presence of any battery or ground condition on the tip or ring leads that would cause a false charge. If no such condition is encountered, the line link primary hold magnet for the called line is operated, completing the connection to the station.

A crosspoint continuity test is then made in which alternating current is used. Satisfactory completion of this test causes the marker to transfer control of the operated hold magnets to the incoming trunk, which releases them after the conversation, and to transmit a release signal to the sender. The sender then releases the connector circuit which releases the marker. The marker, in restoring to normal, releases the number group connector and line choice connector circuits, and the incoming link and line link frames, which also return to normal.

If the information returned by the number group connector circuit indicates that the called line is an individual line and is busy, the marker sets the incoming trunk circuit to transmit the busy signal and restores to normal without calling in the line choice connector circuit or the line link frame.

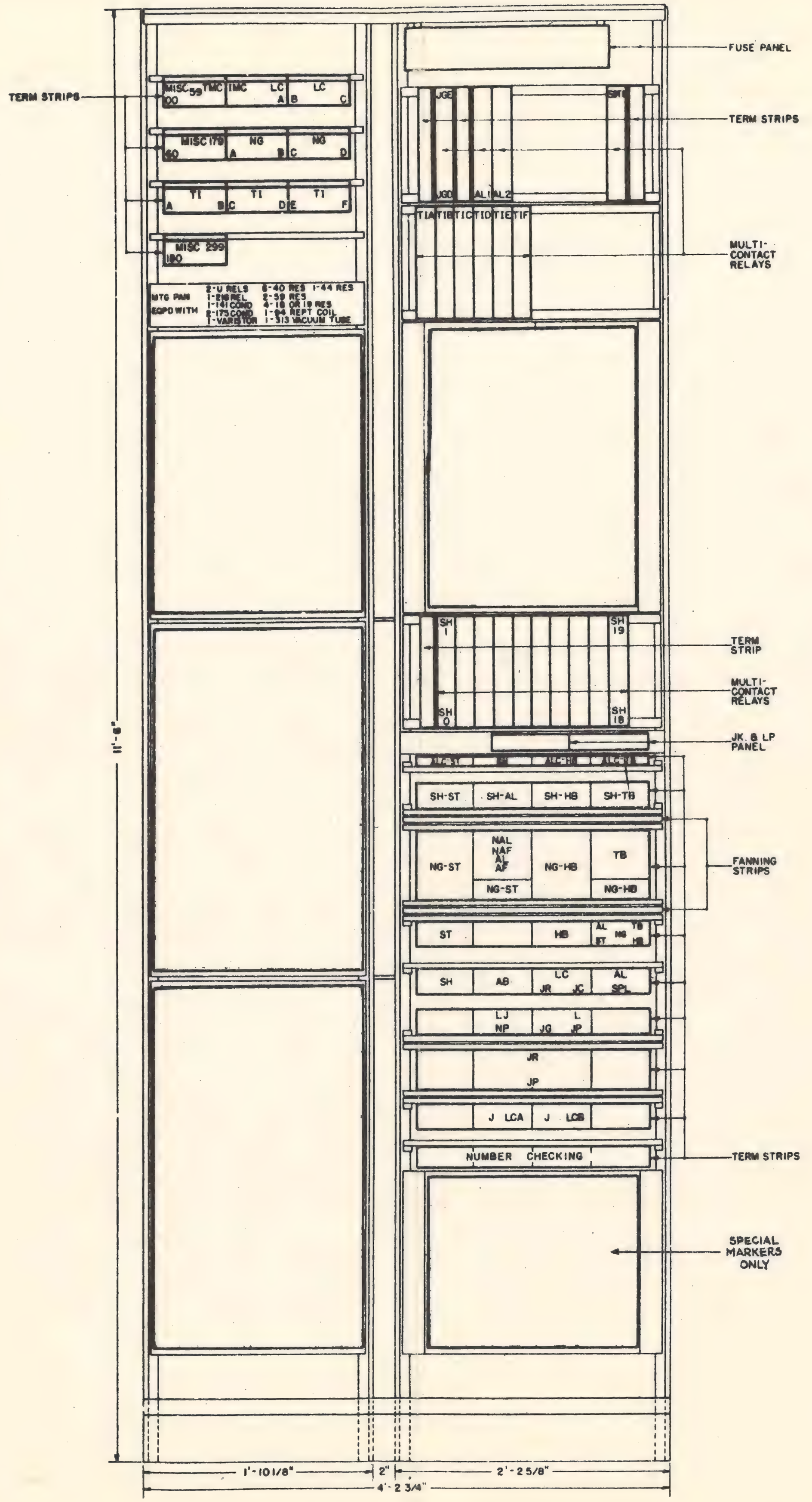
If the called line is a terminal hunting line and is busy, the marker tests successive lines of the PBX group within the twenty block, the limits of the group being indicated to it by the block relay frame. In addition, a group of terminal hunting lines may be extended through any four additional twenty blocks in the same number group for a total of 100 lines, the marker being arranged to test these blocks in succession. Furthermore, blocks of "coded" lines may be substituted for any or all of these blocks, except the first line, such lines being connected to the line link primary switch verticals installed in excess of the 10,000 required for the 10,000 directory numbers of the office.

In addition to the above, any available nonconsecutive directory numbers of the office, and any available coded lines may be used to increase the size of terminal hunting groups.

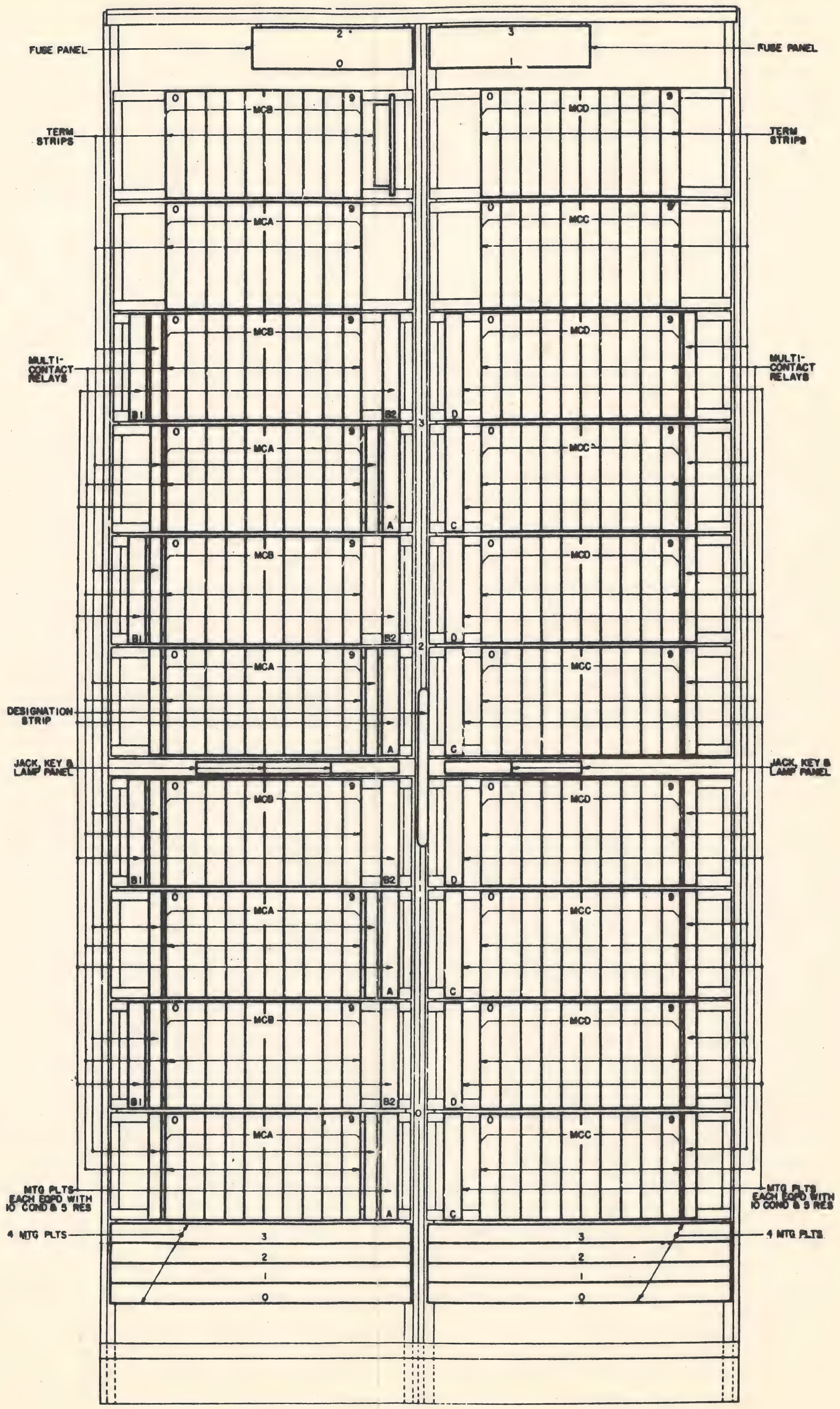
In installations having more than 10 line junctors in each group connecting the incoming frames or incoming groups to the half-choices, 10 of these junctors are included in a first test choice and the remaining junctors are placed in additional test choices, the maximum number of choices being five. Successive test choices are tested by the marker when channels busy conditions are encountered, an overflow signal being returned if no idle channel can be found.

The marker is arranged to route calls for unequipped numbers to an intercept operator.

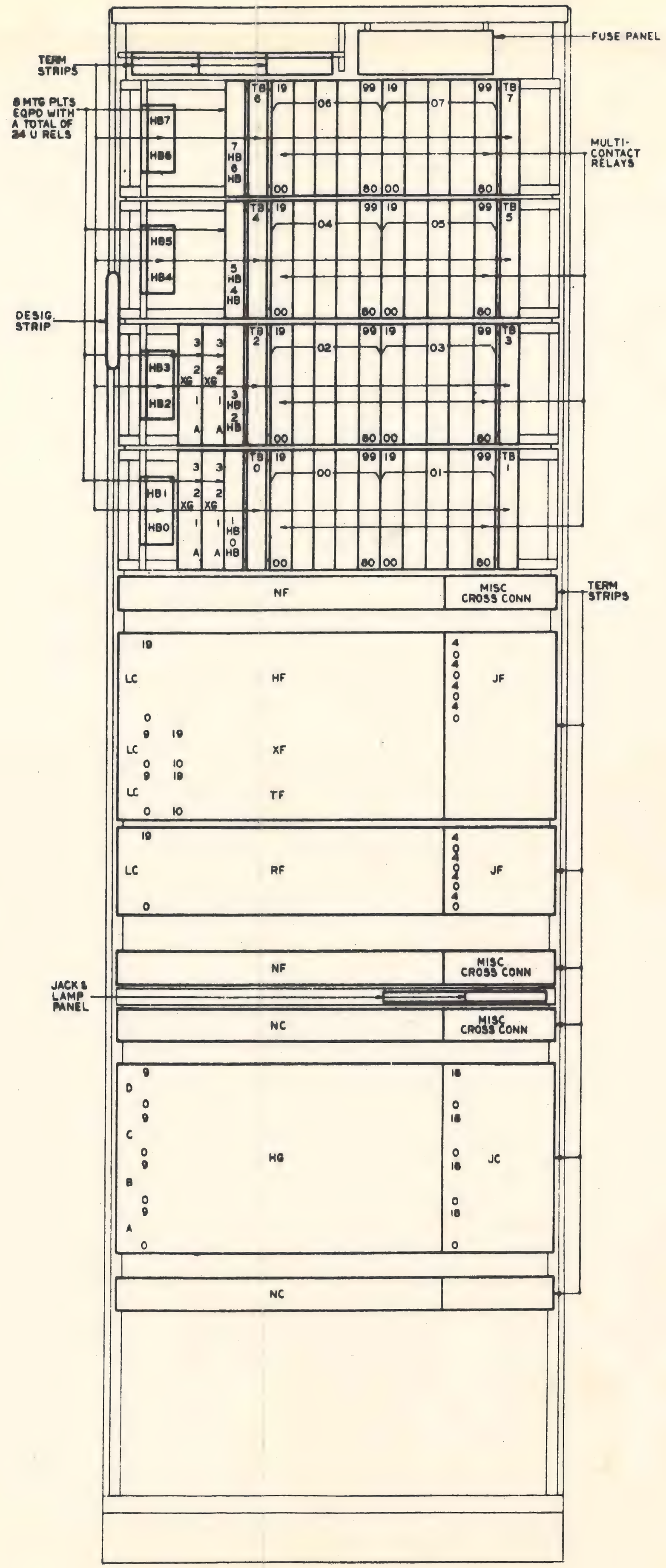
If the terminating marker encounters falsely grounded or crossed leads, or if the circuit functions are blocked for any reason, the marker connects to the terminating trouble indicator to leave a record of the trouble. It then sends a trouble release signal to the connector so that a second trial may be made. A second trouble release signal is transmitted to the sender, causing the circuits to restore.



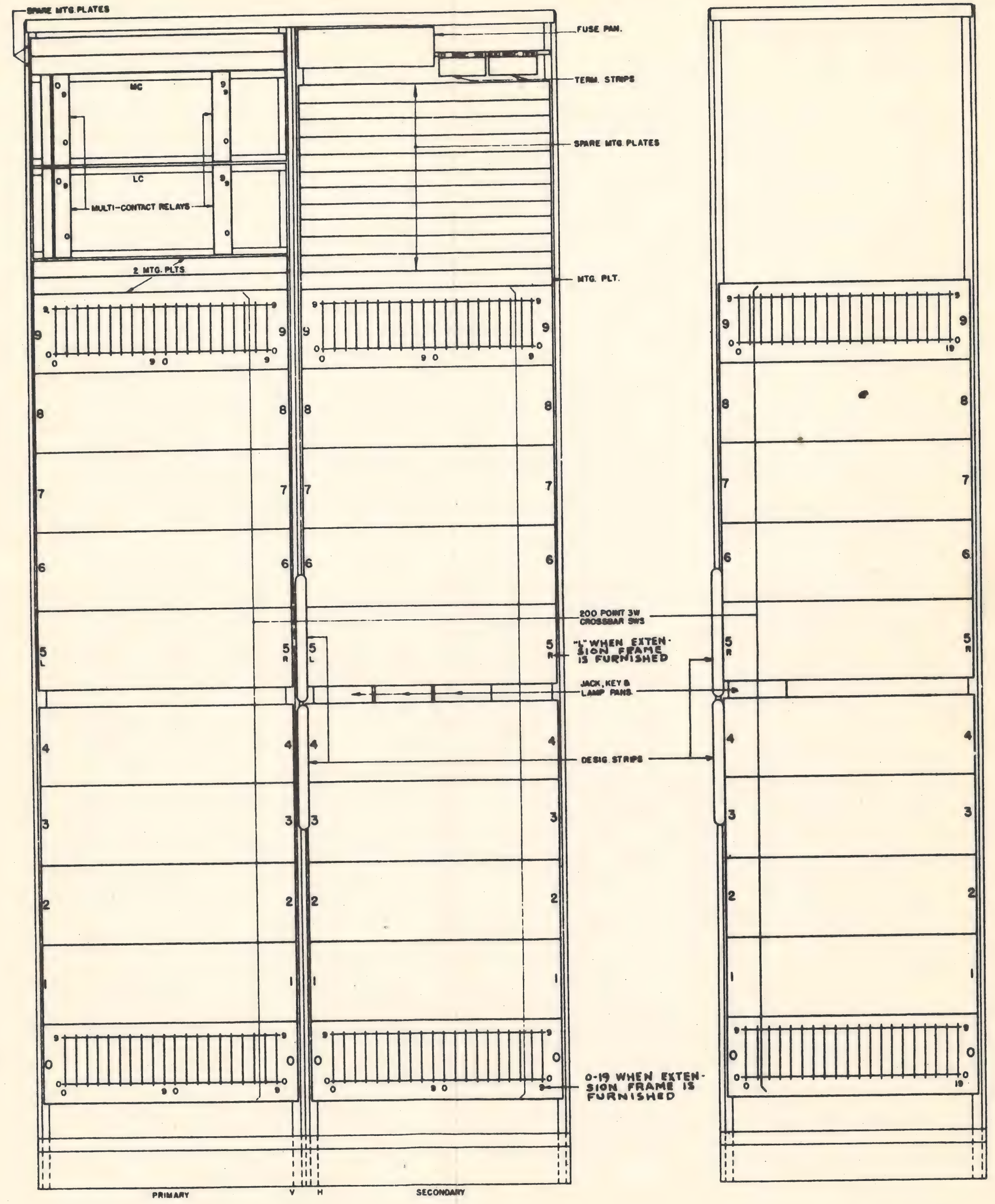
Terminating Marker Frame



Number Group Connector Frame

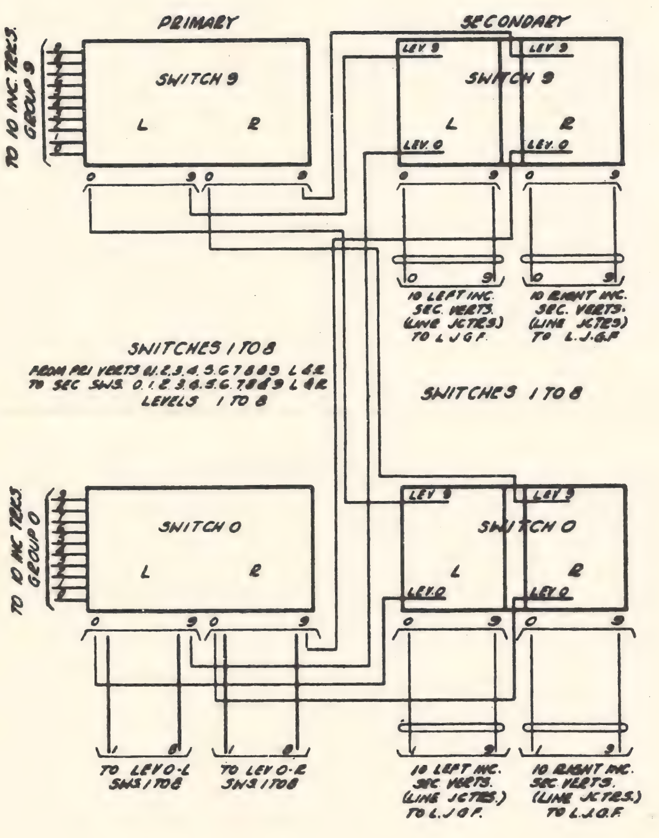


BLOCK RELAY FRAME

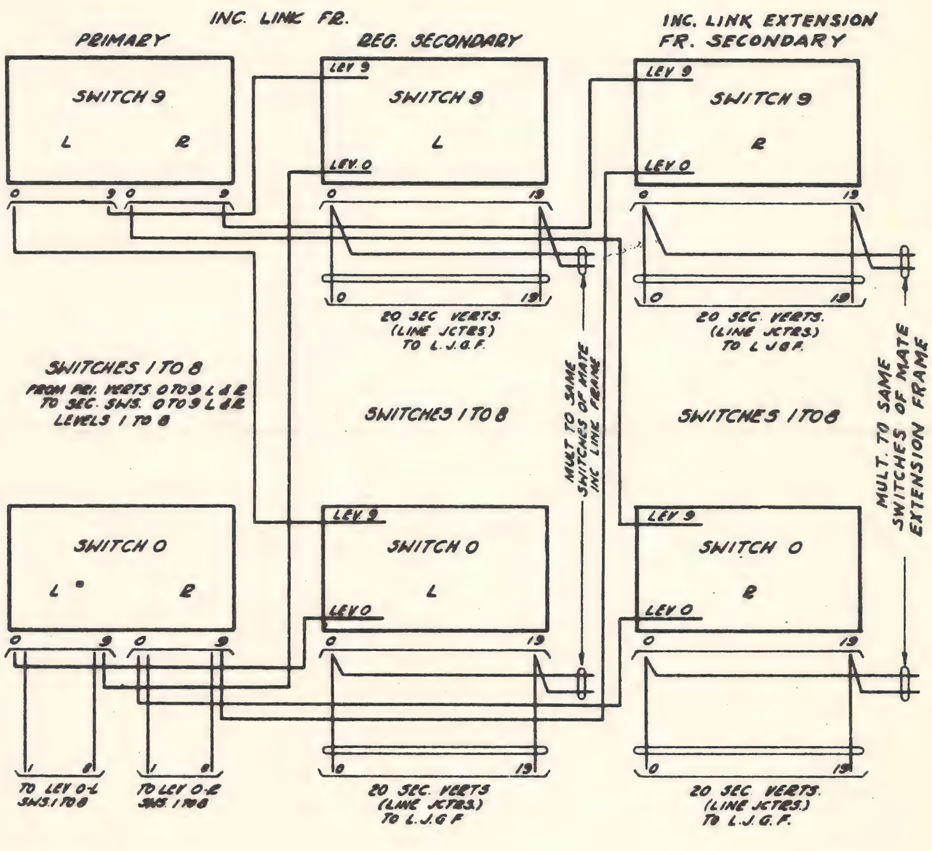


INCOMING LINK FRAME

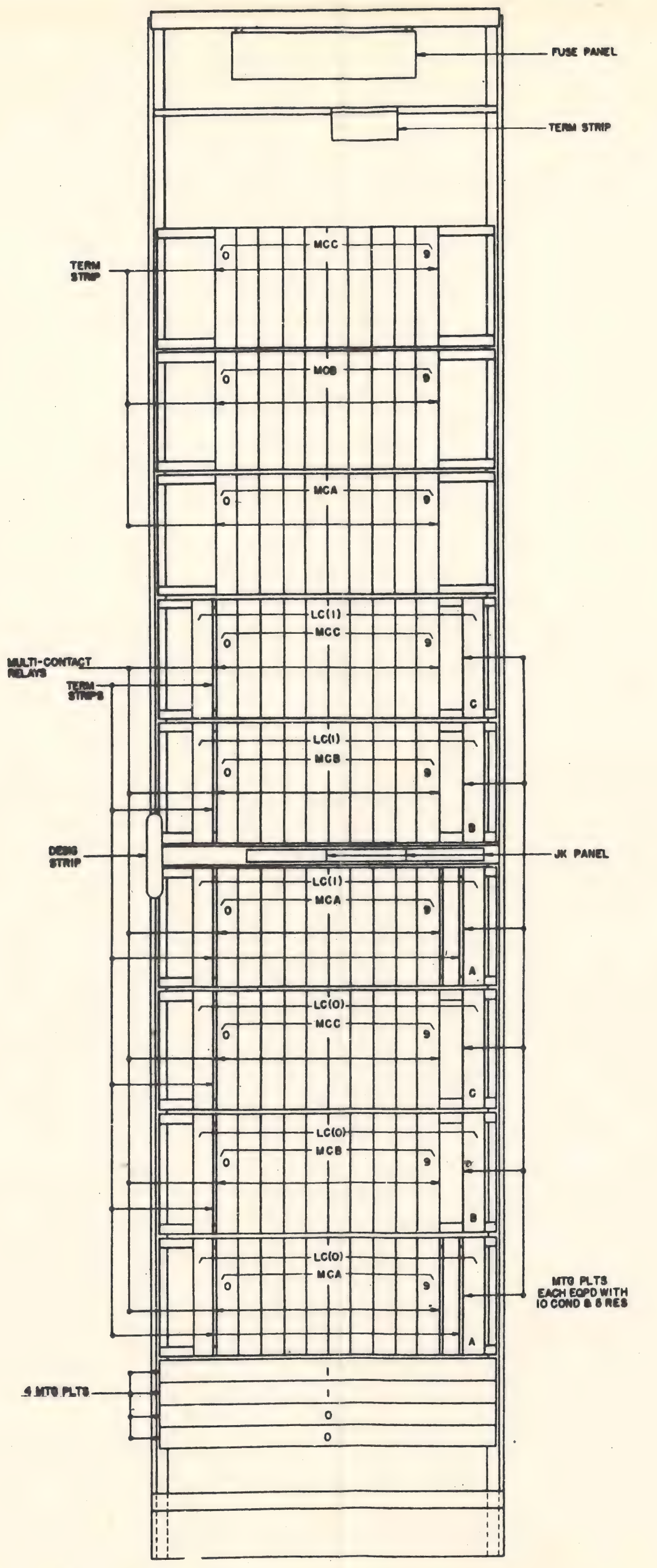
INCOMING LINK EXTENSION FRAME


PRIMARY
SECONDARY
TO 10 INC TRKS. GROUP 9
SWITCH 9
L
R
LEV 9
LEV 0
0
9
10 LEFT INC. SEC. VERTS. (LINE JCTRS) TO L.J.G.F.
10 RIGHT INC. SEC. VERTS. (LINE JCTRS) TO L.J.G.F.
SWITCHES 1 TO 8
FROM PRI VERTS 0.1.2.3.4.5.6.7.8&9 L&R
TO SEC SWS. 0.1.2.3.4.5.6.7.8&9 L&R
LEVELS 1 TO 8
SWITCHES 1 TO 8
TO 10 INC TRKS. GROUP 0
SWITCH 0
TO LEV 0-L SWS 1 TO 8
TO LEV 0-R SWS 1 TO 8
10 LEFT INC. SEC. VERTS. (LINE JCTRS.) TO L.J.G.F.
10 RIGHT INC. SEC. VERTS. (LINE JCTRS.) TO L.J.G.F.

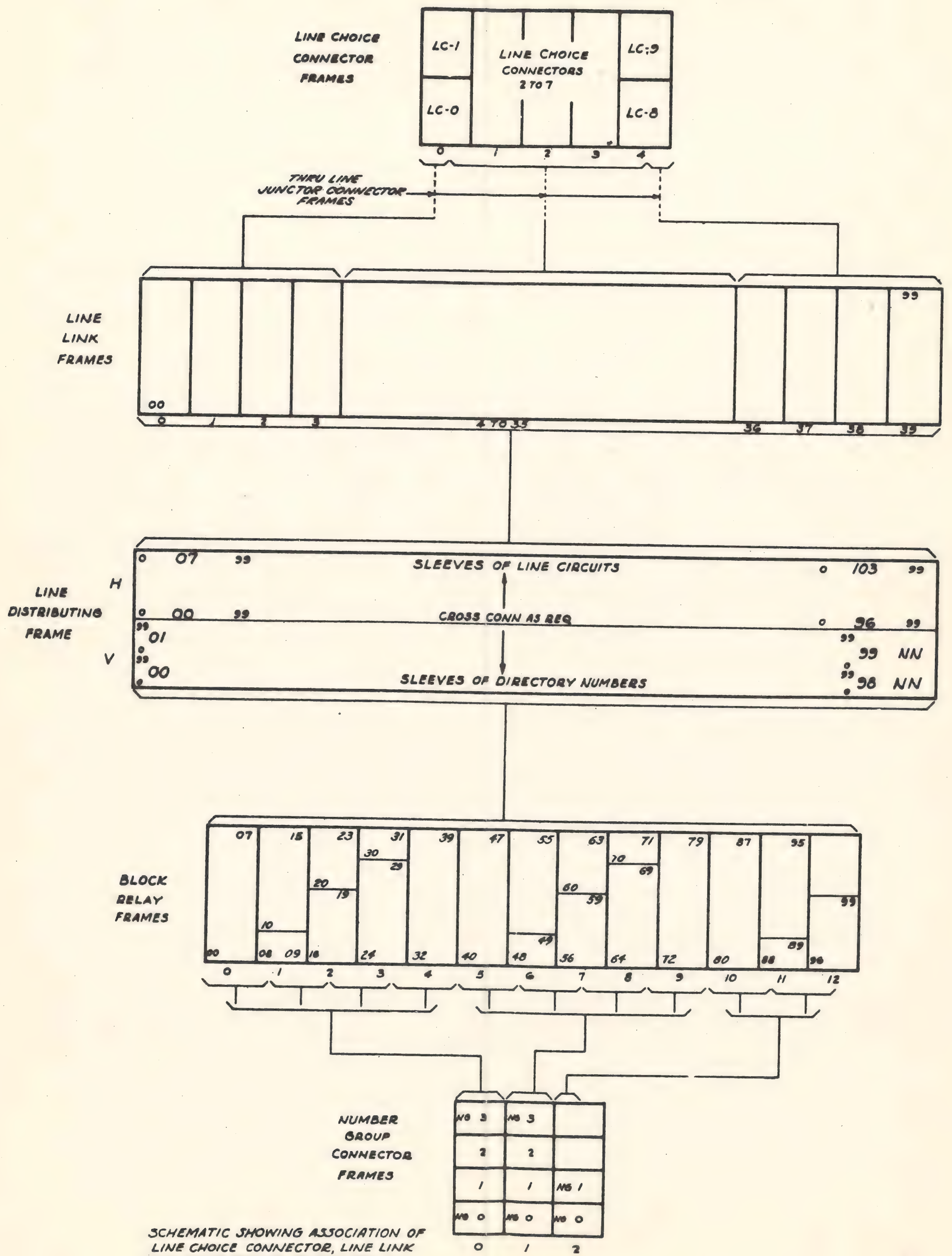
PRIMARY-SECONDARY SWITCH SLIP INCOMING LINK FRAME WITHOUT EXTENSION FRAME - 200 LINE JUNCTORS PER INCOMING LINK FRAME


INC. LINK FR.
PRIMARY
REG. SECONDARY
INC. LINK EXTENSION FR. SECONDARY
SWITCH 9
L
R
LEV 9
LEV 0
0
9
19
20 SEC. VERTS. (LINE JCTRS) TO L.J.G.F.
SWITCHES 1 TO 8
FROM PRI. VERTS 0 TO 9 L&R
TO SEC. SWS. 0 TO 9 L&R
LEVELS 1 TO 8
SWITCHES 1 TO 8
MULT. TO SAME SWITCHES OF MATE INC LINK FRAME
MULT. TO SAME SWITCHES OF MATE EXTENSION FRAME
SWITCH 0
TO LEV 0-L SWS. 1 TO 8
TO LEV 0-R SWS. 1 TO 8
20 SEC. VERTS (LINE JCTRS.) TO L.J.G.F.

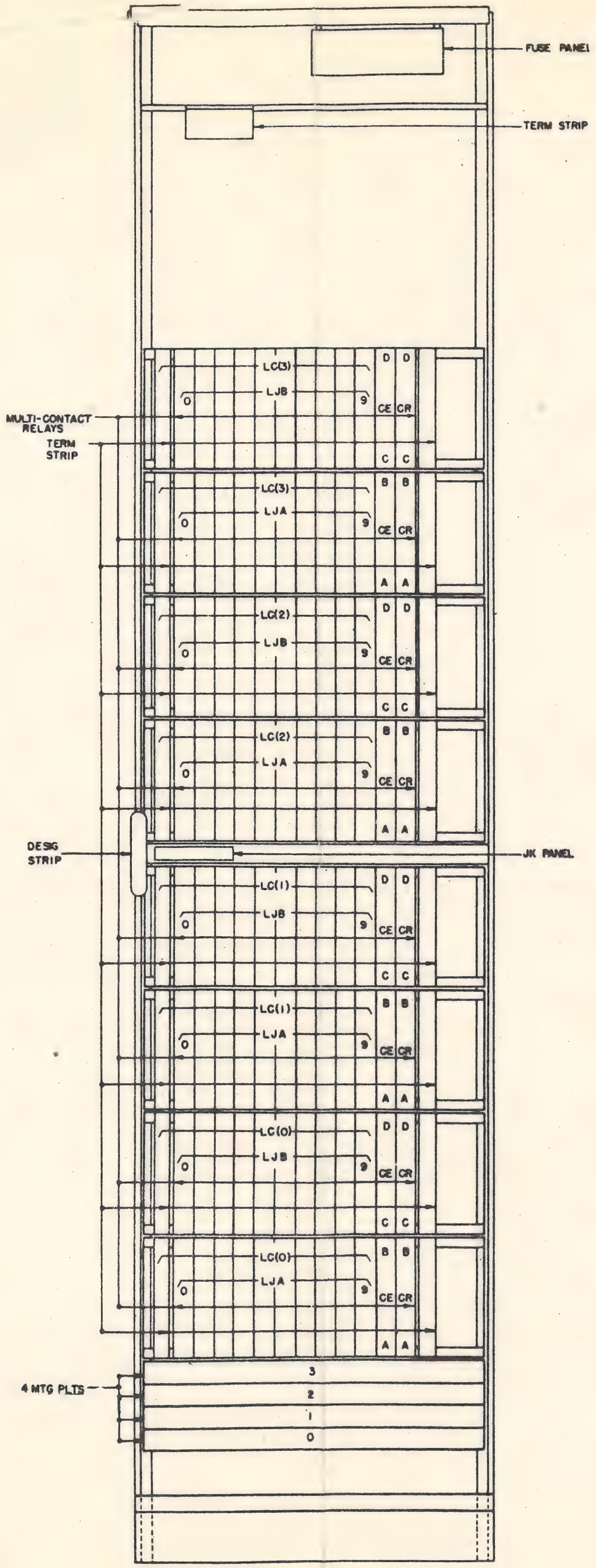
PRIMARY-SECONDARY SWITCH SLIP INCOMING LINK FRAME WITH EXTENSION FRAME - 400 LINE JUNCTORS PER INCOMING LINK GROUP



Line Choice Connector Frame

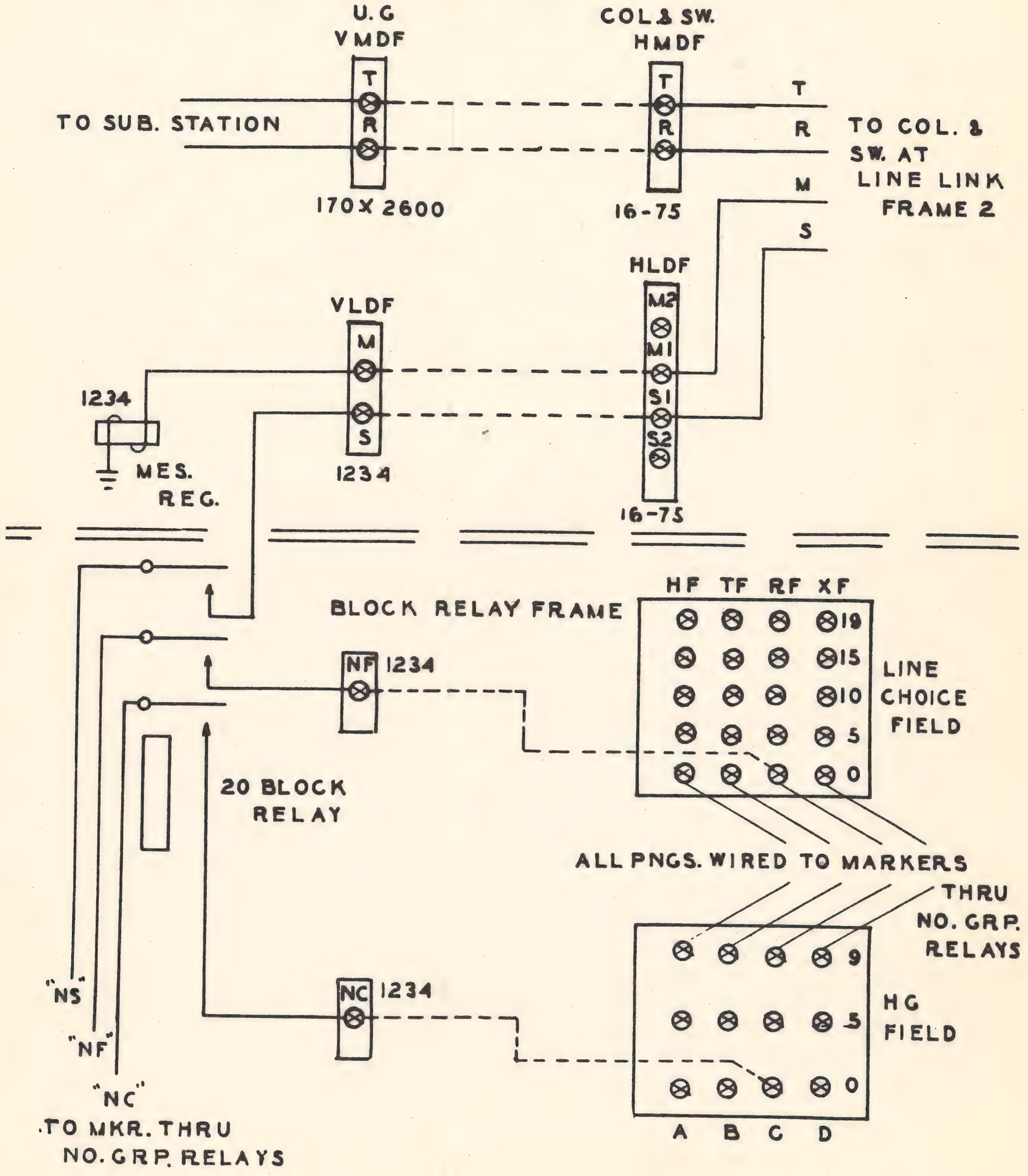


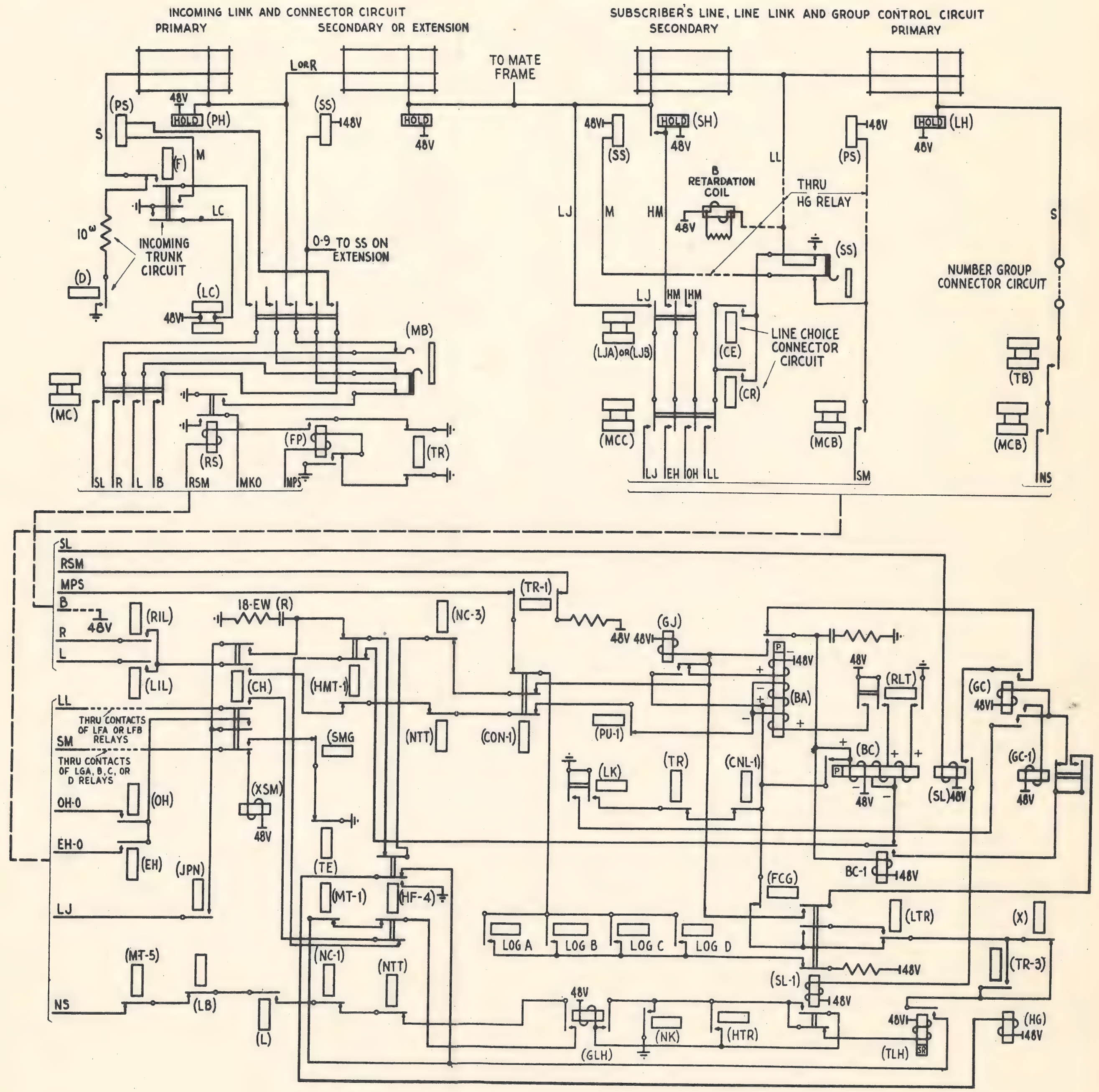
SCHEMATIC SHOWING ASSOCIATION OF LINE CHOICE CONNECTOR, LINE LINK LINE DISTRIBUTING, BLOCK RELAY AND NUMBER GROUP CONNECTOR FRAMES



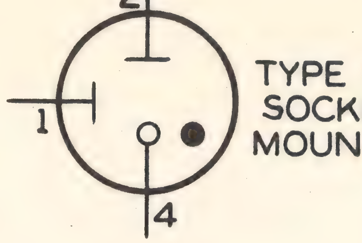
Line Junctor Connector Frame

DIRECT LINE CROSS CONNECTIONS



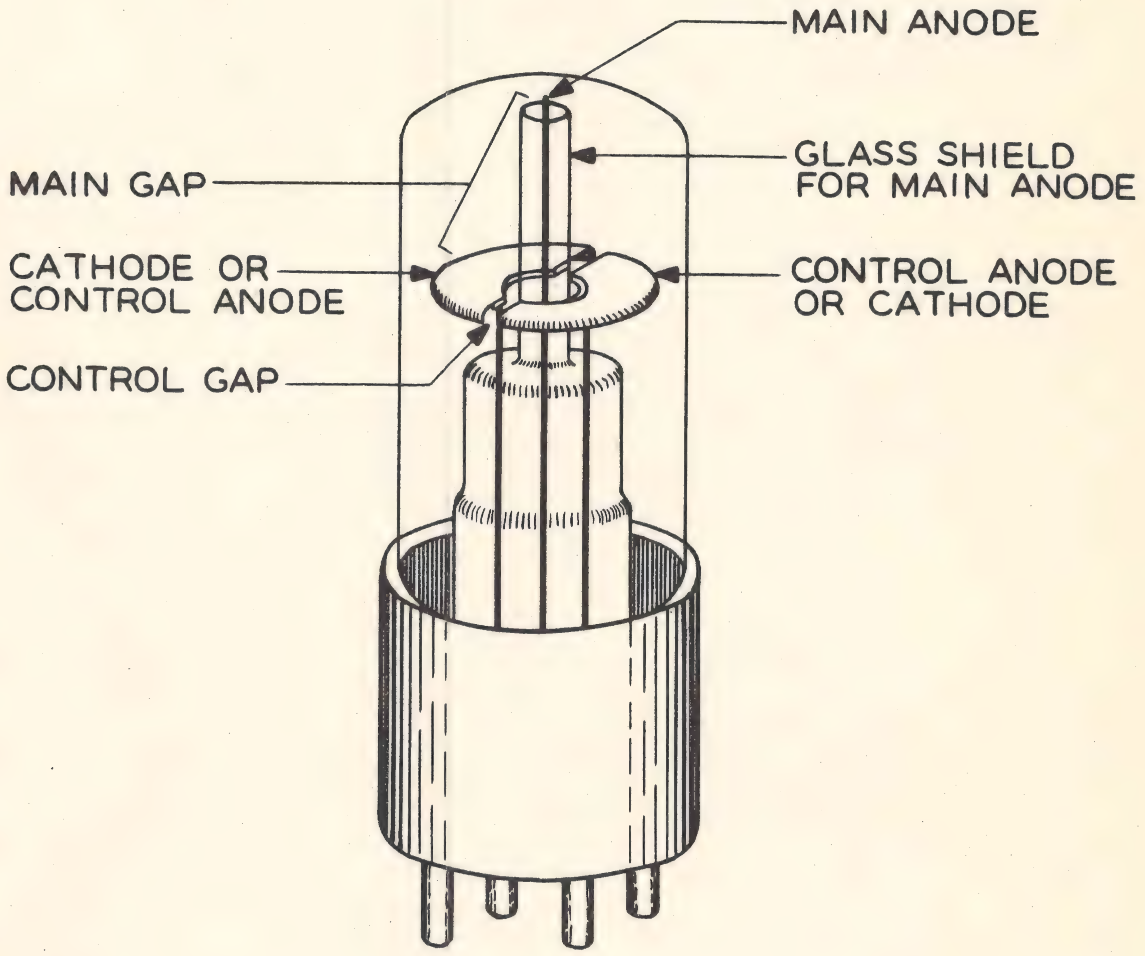


CLOSURE OF CHANNEL CROSSPOINTS
CROSSBAR SYSTEM
Nº 1

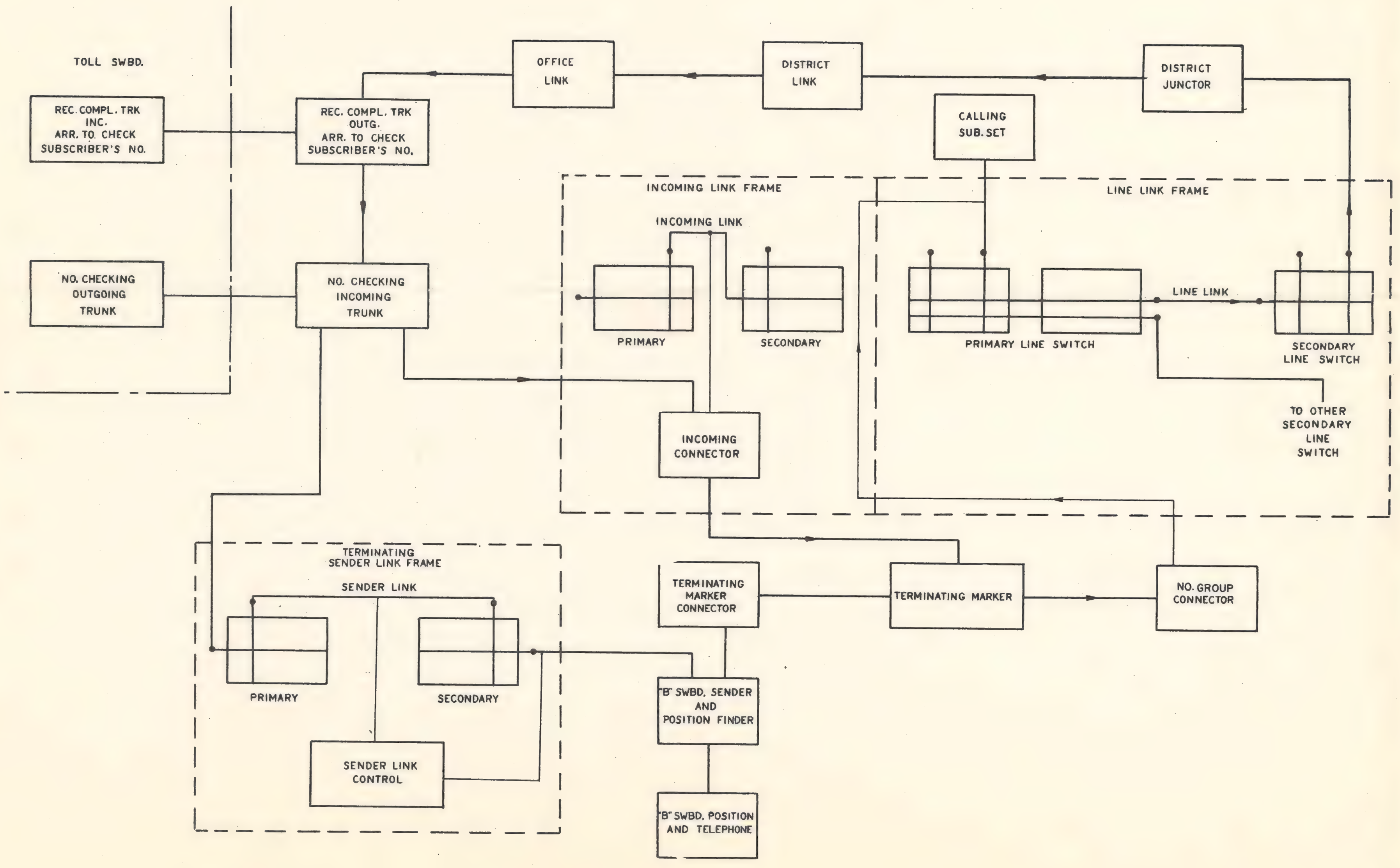


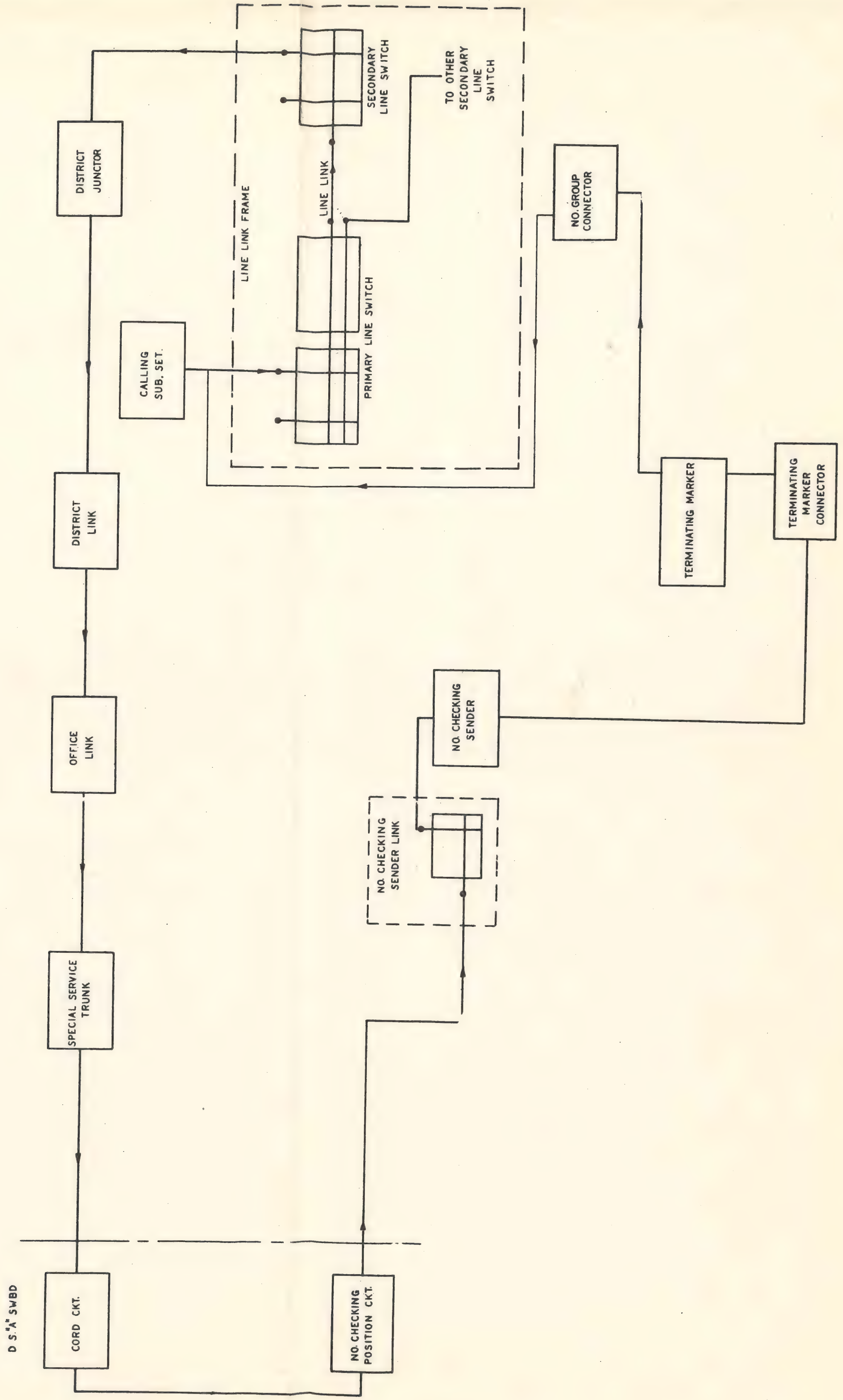
TYPE 313
SOCKET
MOUNTED

TERM	USE
1	CONTROL ANODE
2	MAIN ANODE
4	CATHODE
●	GAS FILLED TUBE



ELEMENTS OF TYPICAL THREE-ELEMENT
COLD-CATHODE TUBE
WESTERN ELECTRIC
313 TYPE


TOLL SWBD.
REC. COMPL. TRK INC. ARR. TO CHECK SUBSCRIBER'S NO.
REC. COMPL. TRK OUTG. ARR. TO CHECK SUBSCRIBER'S NO.
OFFICE LINK
DISTRICT LINK
DISTRICT JUNCTOR
CALLING SUB. SET
NO. CHECKING OUTGOING TRUNK
NO. CHECKING INCOMING TRUNK
INCOMING LINK FRAME
INCOMING LINK
PRIMARY
SECONDARY
INCOMING CONNECTOR
LINE LINK FRAME
LINE LINK
PRIMARY LINE SWITCH
SECONDARY LINE SWITCH
TO OTHER SECONDARY LINE SWITCH
TERMINATING SENDER LINK FRAME
SENDER LINK
PRIMARY
SECONDARY
SENDER LINK CONTROL
TERMINATING MARKER CONNECTOR
TERMINATING MARKER
NO. GROUP CONNECTOR
"B" SWBD. SENDER AND POSITION FINDER
"B" SWBD. POSITION AND TELEPHONE


D S "A" SWBD
CORD CKT.
NO. CHECKING POSITION CKT.
SPECIAL SERVICE TRUNK
OFFICE LINK
DISTRICT LINK
DISTRICT JUNCTOR
NO. CHECKING SENDER LINK
NO. CHECKING SENDER
CALLING SUB. SET.
LINE LINK FRAME
PRIMARY LINE SWITCH
LINE LINK
SECONDARY LINE SWITCH
TO OTHER SECONDARY LINE SWITCH
NO. GROUP CONNECTOR
TERMINATING MARKER
TERMINATING MARKER CONNECTOR

CHAPTER 8

SECTION 2

METHOD OF OPERATION

Terminating Marker Circuit	SD-25283-01
Number Group Connector Circuit	SD-25276-01
Incoming Link and Connector Circuit 160 Trunk Capacity	SD-25457-01
Incoming Link and Connector Circuit 100 Trunk Capacity	SD-25032-01
Line Choice Connector Circuit	SD-25275-01

MARCH 1954

SELECTION OF NUMBER GROUP CONNECTOR CIRCUIT
AND
SEIZURE OF INCOMING LINK AND CONNECTOR CIRCUIT SC 501

SEIZURE OF TERMINATING MARKER OS 501 and 502

The terminating marker connector circuit, upon seizing a terminating marker, operates the marker circuit, CBR and CBS relays by connecting ground to the DB lead, these relays in turn closing ground to the associated CB leads to all the connectors. This causes the marker to test busy at all points at which it can be selected. Ground connected to the DB lead is also closed to the marker circuit DB interrupter. In addition, the CBS relay opens a multiple contact in the GT lead circuit, which is similar to an operation in the originating end. This lead controls the operation of an alarm relay, which indicates that calls are blocked by the sequence regulator circuit in the connectors even though markers are available.

The connector circuit, in addition, closes ground to the TM and CKG leads to the marker and releases the marker circuit DA-1 and DA-2 relays, these relays in releasing connecting additional grounds to the TM lead.

CHECK OF RECEIVING LEADS OS 502

Before any information is transmitted from the terminating sender to the terminating marker, the integrity of all leads connected between the sender and the marker through the marker connector is checked. As shown on SC 501 the CKG lead is important in starting this circuit function. From ground on the CKG lead, marker relays CK-6, CK-7 and CK-10 relays will operate in parallel connecting ground to the off normal ground leads.

Marker circuit CK-9 relay operates and locks.

> The CK-9 relay is used to insure release of the timing circuit between successive calls by cancelling preliminary stage timing and starting first stage timing. Should the CK-9 relay not operate after the TM lead is grounded a circuit is provided to operate the TMS-2 relay. This actuates an alarm indicating that the TM lead is grounded, but the marker has not been seized.

Marker circuit TMS-1 relay operates and locks.

> The TMS-1 relay operating connects ground to the TM interrupter starting the marker time measure circuits.

Marker circuit TMS-3 relay operates.

Marker circuit CK-1 relay operates, and ground is connected to the CK-1 lead to the connector circuit, in parallel.

Marker circuit CK-2 relay operates, and ground is connected to the CK-2 lead to the connector circuit, in parallel.

Marker circuit CK-3 relay operates, and ground is connected to the CK-3 and CK-4 leads to the connector circuit, in parallel.

RECEIVING INFORMATION FROM SENDER OS 418

When the connector circuit operates the multi-contact relay for the selected marker, closing the receiving and check leads between the sender and the marker, with the CK-6 relay operated, the following takes place:

All marker recording relays operate.

> The marker recording relays are TH-1, 2, 4 and 8, H-1, 2, 4, 5 and 5', T-1, 2, 4 and 5 and U-1, 2, 4, and 5, used to record the called line number, relays F-1, 2, 4, 5, 10 and 10', for recording the incoming link and connector frame number at which the calling trunk appears, and relays RO, TR-2 and TR-3.
>
> These relays operate from grounds on their respective receiving leads, all the receiving leads being closed in the sender either to ground or to the check leads grounded by the marker as above, except that the TR-2 lead (for second trial indication) is closed to the CK-2 lead (or to ground on a second trial) in the connector circuit. This lead does not extend to the sender.

The marker TR-1, CK-4, and CK-5 relays operate.

> The marker CK-4 relay locks and the CK-5 holds in parallel.
>
> The marker CK-5 relay locks and the CK-4 holds in parallel.
>
> In order for the CK-4 and CK-5 relays to operate, all the recording relays (and the CK-1, 2 and 3 relays) must be operated. This circuit arrangement is used to check all the receiving and check leads on each call. An open receiving or check lead, by preventing the operation of these relays, would cause the marker to time out and actuate an alarm.

The operation of the CK-4 and CK-5 relays will release the CK-1, CK-2 and CK-3 relays, removing ground from leads CK-1, CK-2, CK-3 and CK-4 to the connector circuit.

The removal of ground from the check leads causes the marker recording relays not required for the call release.

> The relays to release at this time are those connected in the sender (or the connector in the case of the TR-2 and TR-3 relays) to the check leads. The TR-1 relay releases when the TR-3 releases. This leaves operated the relays required for the call, which are held by direct grounds from the sender registers.

The numerical and frame recording relays are left operated at this time in combinations which add up to the digits and the frame number, except for relays H-5' and F-10', which are auxiliary to the H-5 and F-10 relays.

Release of the CK-1, CK-2 and CK-3 relays as above indicates that there are no false grounds on the receiving leads not required for registration of the call, or on any of the check leads. If one of these receiving leads were falsely grounded, the false ground would be connected through the sender registers (or in the connector circuit for the TR-2 lead) to one of the check leads, and in this case, or if a check lead itself were falsely grounded, the check relay to which the lead is wired would be held operated. Failure of one or more of relays CK-1, CK-2 and CK-3 to release would block the marker and actuate an alarm.

ADDITIONAL OPERATIONS CAUSED BY THE CK-6 AND CK-7 RELAYS

While the above operations are taking place, certain other relay operations and lead closures are caused by the CK-6 and CK-7 relays, in preparation for later functions of the circuit, as follows:

Marker Circuit INA relay operates. OS 523

Marker Circuit RLT relay operates. OS 502

Battery and ground are connected to windings of the BC, REG, TLT and TKT relays, causing their armatures to close their back contacts, if not already in this position. OS 503, 515 and 518.

These relays are non-biased polarized relays connected differentially. For the TLT and TKT relays the opposing windings are energized at this time, the release winding being stronger than the operate winding. For the REG relay the release winding is energized.

Upon seizure of the marker, the armatures of these relays may be in any position, The circuits to close and hold their back contacts as above are connected at this time to prepare them for use later in the call, when the BC relay will be used to test the sleeve of the selected line link and the TLT and TKT relays will operate in conjunction with timing condensers to provide certain time intervals.

The REG relay is used in connection with a per cent load register.

Marker circuit LLB relay operates. OS 502

Battery is connected to the windings of the AB and LL relays.

Marker circuit OR relay operates. OS 503

The release winding of the XTB relay is energized causing its armature to close on the back contact, if not already in this position. OS 510

This relay is used for cross-tests.

Marker circuit ALW relay operates, if normal, and the ALZ relay is short-circuited, in parallel. OS 527

> The ALW and ALZ relays are used in connection with "allotted" P.B.X. groups. Both of these relays are normal or both of them are left operated from the previous call when the marker is seized. If they are normal, the ALW relay operates as above and the ALZ relay is short-circuited; otherwise the ALW relay is short-circuited and released at this time, the ALZ relay remaining operated.

Marker circuit XS-3 and LTR relays operate in parallel. OS 502

> The XS-3 relay locks and the LTR relay holds, in parallel.
>
> The path to operate the XS-3 and LTR relays is traced through normal contacts of the XS-2 relay. The XS-2 relay is normal at this time, if the time interval between release of the marker on the previous call and its reseizure is greater than the combined release time of the slow release XS-1 and XS-2 relays. These relays are provided to measure the time interval between successive calls, so that in periods of heavy traffic marker holding time may be reduced by the elimination of certain tests. If the XS-2 relay has not yet released from the previous call, indicating heavy traffic, the XS-3 and LTR relays do not operate. This condition is described later, it being assumed for this call that the XS-2 relay is normal, indicating light traffic, and that the XS-3 and LTR relays operate as above.

TEST FOR FALSELY GROUNDED NS LEADS OS 503, 510

Operation of the XS-3 relay connects the XS relay winding, through the windings of the marker circuit S relays, to the "NS" leads to the number group connector circuits. OS 503

There are 20 S relays, designated 0 to 19, in the marker, used to indicate busy conditions in a selected block of 20 lines. There are 20 NS leads, similarly designated, connecting the marker to the number group connector circuits. These leads are multiplied at all of the number group connector circuits for use, as required, with any selected twenty block relay in making the line busy test. The XS relay is connected to these leads in order to test for the presence of false grounds, which if not detected would cause false line busy indications. If the XS relay operates, due to such a condition, it sticks the circuit. It is assumed for this call that there are no false grounds on these leads and that the XS relay does not operate.

Marker circuit XS-1 relay operates. OS 502

Marker circuit XS-2 relay operates.

> If these relays had not released from the previous call, they would be held, rather than operated, by operation of the CK-5 relay.

Marker circuit CK-8 relay operates. OS 502

> The windings of the L relays are disconnected from the winding of the XL relay and connected to battery. OS 510

There are 20 L relays in the marker, designated 0 to 19, used in the selection of a line out of a block of 20 lines. The XL relay is provided to detect false grounds on L relay windings. If such a false ground is present, previous to the operation of the CK-8 relay, the XL relay operates and sticks the circuit. It is assumed in this case that the XL relay does not operate.

The release winding of the GT and XPS relays are energized causing their armatures to close on the back contacts if not already in this position. OS 502, 509.

The GT relay will be used to test the connection after it has been established to the called line. The XPS relay is used to detect crosses on the incoming primary select magnet leads. In this case it is assumed that the XPS relay did not operate.

NUMERICAL TRANSLATION OS 504

The called line number, recorded in the marker circuit, is translated into terms of numerical blocks of 500 numbers each and further translated into numerical blocks of 100 each, so that the marker can determine the number groups and block relay frame in which the number is contained. In addition, the 100 numbers of a block are divided into blocks of 20 numbers each. These operations take place when the CK-1, CK-2 and CK-3 relays release.

A marker circuit FH relay, corresponding to the five hundred block which includes the called number, will operate when the CK-1 relay releases.

There is an FH relay in the marker for each numerically consecutive block of 500 directory and coded numbers, having one or more numbers assigned. Twenty-five of these relays would be required for the special markers in a fully equipped office, while only twenty would be required for the other markers. The twenty are designated 0 to 9 and 0' to 9' and are used for the directory numbers 0000 to 9999. The extra five FH relays in the special markers are designated 0X, 0'X, IX, I'X and 2X and provide for 2500 coded numbers. There are 100 coded lines per number group and they are designated A-00 to A-99, for the first number group to Z-00 to Z-99 for the twenty-fourth and AA-00 to AA-99 for the twenty-fifth number groups. The alphabetical prefix "I" and "O" are not used to designate coded lines. The coded number feature will be described later.

The relay to operate is determined by the thousands recording relays and the H-5 and H-5' hundreds recording relays, operated as required during registration. The numerical designation of the FH relay to operate is the same as the thousands digit of the called number. Relays FH-0 to 9 are used for the first five hundred block of each thousand numbers, and relays 0' to 9' for the second.

If the marker is one of the special markers (No. 0 or No. 1) the operate path of the FH relay will include the EXA and EXB relays.

This table indicates the FH relay operated for any directory or coded number recorded. OS 504

Directory Number Recorded	FH Relay Operated	Recording Relays Operated
0000 - 0499	FH-0	None
0500 - 0999	FH-0'	H-5, H-5'
1000 - 1499	FH-1	TH-1
1500 - 1999	FH-1'	H-5, H-5'. TH-1
2000 - 2499	FH-2	TH-2
2500 - 2999	FH-2'	H-5, H-5', TH-2
3000 - 3499	FH-3	TH-1, TH-2
3500 - 3999	FH-3'	H-5, H-5', TH-1, TH-2
4000 - 4499	FH-4	TH-4
4500 - 4999	FH-4'	H-5, H-5', TH-4
5000 - 5499	FH-5	TH-1, TH-4
5500 - 5999	FH-5'	H-5, H-5', TH-1, TH-4
6000 - 6499	FH-6	TH-2, TH-4
6500 - 6999	FH-6'	H-5, H-5', TH-2, TH-4
7000 - 7499	FH-7	TH-1, TH-2, TH-4
7500 - 7999	FH-7'	H-5, H-5', TH-1, TH-2, TH-4
8000 - 8499	FH-8	TH-8
8500 - 8999	FH-8'	H-5, H-5', TH-8
9000 - 9499	FH-9	TH-1, TH-8
9500 - 9999	FH-9'	H-5, H-5', TH-1, TH-8
Coded Number Recorded		
0000 - 0499	FH-0X	None
0500 - 0999	FH-0'X	H-5, H-5'
1000 - 1499	FH-1X	TH-1
1500 - 1999	FH-1'X	H-5, H-5', TH-1
2000 - 2499	FH-2X	TH-2

Since any marker must have a series of four digits to route a call, it is necessary to assign a thousands and hundreds digit for each group of 100 coded lines. This is done as follows:

A coded lines = 00 thousands and hundreds
B coded lines = 01 thousands and hundreds
to Z coded lines = 23 thousands and hundreds
AA coded lines = 24 thousands and hundreds

Thus a call for line F-49 would become a call for 0549 of the extra number series. This special marker feature for routings to these coded lines is required chiefly for test calls which will be described later.

A marker HN relay, corresponding to the required hundred block, will operate when the CK-2 relay releases. OS 504

There are five HN relays in the marker, designated 0 to 4, used for the hundred block indication. The relay to operate is determined by the hundreds recording relays H-1, H-2 and H-4, operated as required, during registration. The numerical designation of the HN relay to operate is the same as the hundreds digit of the called number, this digit is 0 to 4, or is five less than the hundreds digit, if it is 5 to 9.

Hundreds Digit	HN Relay Operated	Recording Relays Operated
0 or 5	HN-0	None
1 or 6	HN-1	H-1
2 or 7	HN-2	H-2
3 or 8	HN-3	H-1, H-2
4 or 9	HN-4	H-4

A marker TB relay corresponding to the required twenty block will operate when the CK-3 relay releases. OS 510

There are five TB relays in the marker designated 0 to 4, used for the twenty block indication. The relay to operate is determined by the tens recording relays, operated as required during registration. The TB-0 relay operates if the tens digit is 0 or 1, the TB-1 relay for tens digits 2 and 3, etc.

The marker TEV or TOD relay will operate.

The TEV and TOD relays operate for even and odd tens digits, respectively, under control of the T-1 and T-5 recording relays. Both of these relays operated or both normal indicates that the tens digit is even, causing the TEV relay to operate. One of relays T-1 and T-5 operated and the other normal, however, indicates an odd tens digit and causes the TOD relay to operate.

This indication, together with the registration on the units recording relays is used later to enable the marker to select the called number of the 20 numbers in the twenty block.

Tens Digit	TB Relay Operated	Recording and, TEV or TOD Relays Operated	
0 or 1	TB-0	TEV	or TOD, T-1
2 or 3	TB-1	TEV, T-2	or TOD, T-1, T-2
4 or 5	TB-2	TEV, T-4	or TOD, T-5
6 or 7	TB-3	TEV, T-1, T-5	or TOD, T-2, T-5
8 or 9	TB-4	TEV, T-1, T-2, T-5	or TOD, T-4, T-5

The HP relay operates.

> The HP relay to operate is controlled by the TB relay operated, relays HP-0, 2, 4, 6 and 8 corresponding respectively to relays TB-0, 1, 2, 3 and 4.
>
> While the HP relays are used in regular marker operation, they are provided primarily for terminal hunting progress in P.B.X. groups consisting of two or more twenty blocks.

The XTL relay is disconnected from one of the TB-0 to 4 leads to the number group connector circuits.

> The XTL relay is provided to detect false grounds on the TB leads, which are multipled at all of the number group connector circuits for use in the selection of a twenty block. Operation of the XTL relay, due to the presence of a false ground, sticks the circuit. It is assumed for this call that the XTL relay does not operate.

TEST FOR CROSSED NS LEADS OS 503 or 510

Operation of the XS-3 relay connected the winding of the XS relay to the 20 NS leads to the number group connector circuits, in order to test for false grounds on these leads. When numerical translation is completed, an additional test is made on the NS leads to determine whether the one to be used for the call is crossed with any of the other 19. This test starts upon operation of the CK-8 relay and will remain on the leads until the XS-3 relay releases. When the CK-8 relay operates it will operate the XS-4 relay.

Marker circuit LE relays will now operate, and from any LE operated the LE 7 will operate.

From the operated XS-4 relay, the XS-5 relay will operate.

A marker circuit L relay will operate, corresponding to the location of the called number in the twenty block.

> The L relay to operate is determined by the units registration and whichever of relays TEV and TOD are operated.
>
> The LE-1 to LE-6 relays and LE-8 to LE-12 perform other incidental functions, a description of which is omitted at this time as they do not affect the operation of the circuit. The LE relays will reoperate later for the selection of the called line where their functions at that time will be described.

Ground will now be connected to the NS lead to the number group connector circuit by the operated L relay. OS 510

> This ground is furnished by the terminating trouble indicator circuit on the XNS lead to the marker. If the NS lead to which it is connected is crossed with any other NS lead, this ground will return by way of the crossed lead,

through normal contacts of the corresponding L relay, through the winding of the associated S relay to the XS relay winding, operating the relay. If the XS relay operates, it sticks the circuit. It is assumed for this call that the required NS lead is not crossed and that the XS relay does not operate.

Ground connected at this time to NF and NC leads to the number group connector circuit, by operation of the L relay, performs no useful function at this time.

SEIZURE OF NUMBER GROUP CONNECTOR CIRCUIT OS 504

The number group connector circuit is seized before the other frames required for the call because in most cases marker holding time is reduced. Also, a definite sequence in the seizures of frame lockout circuits is required to prevent markers from mutually excluding each other from desired frames.

There is a start lead per number group connector per marker, these leads being brought into the respective markers and terminated at punchings designated NG-ST-0 to NG-ST-24, for maximum of 25 number group connectors per office, or as required if less than 25 of these circuits are provided. RM 517.

There are five ST punchings connected to contacts of each of the marker circuit FH relays. Each of these punchings represents a block of 100 numbers, one of them being selected on each call by operation of an FH relay and an HN relay. For each hundred block with one or more numbers assigned as call numbers, the corresponding ST terminal of SD figure 3 is cross-connected in each marker, to the NG-ST terminal of SD figure 7 which represents the number group in which the hundred block is located, except for certain special cases.

The numbers in a number group are usually in consecutive order. However, with this cross-connecting arrangement, any hundred block may be located in any number group.

A number group may include a maximum of 2500 numbers, or 25 hundred blocks. A maximum of 25 HB leads per marker are provided, for use in the selection of the required hundred block in a selected number group, these leads being multipled at the number group connector circuits for use with any one of them that may be required for a call, and terminating in the markers at punchings NG-HB-0 to NG-HB-24 or as required.

The number of NG-HB leads to be wired is determined by the maximum blocks of 100 numbers each, that are provided in any number group connector in the office. The HB-24 lead in each number group is reserved for the coded numbers connected by jump hunting.

At the FH relay contacts, there is an HB punching corresponding to each of the ST punchings, also representing the block of 100 numbers with which the ST punching is associated. For each hundred block with one or more numbers assigned as call numbers, the corresponding HB terminal of figure 3 (with certain exceptions) is cross-connected, in each marker, to the NG-HB terminal of figure 7 which represents the location of the hundred block in the number group.

With this cross-connecting arrangement, any block of 100 numbers, regardless of the numbers which it represents, may be associated with any of leads NG-HB-24, as required for its selection in the number group.

With cross-connections made as above, operation of an FH relay and an HN relay causes the required number group conductor circuit to be selected and to advance as follows:

Each number group connector circuit includes an MP relay for each marker, wired as shown in figures 2A, 2B and 2C. Each frame also has a corresponding set of E relays, wired in a similar manner, for emergency use. Either the regular or the emergency circuit may be used in connecting the circuit to a marker, their function being to prevent simultaneous connection of two or more markers to the number group connector circuit. It is assumed for this call that the regular circuit is in use.

The MP relay to operate is the one for the calling marker in the required number group connector circuit, as determined by numerical translation.

The operated MP relay locks, unless it is the one for the last marker.

Number group connector MCA to D relays.

Each number group connector circuit includes marker connector relays MCA, MCB, MCC and MCD for each marker. The MCA relay to operate is the one associated with the operated MP relay.

Two or more MP relays can operate simultaneously. Additional MP relays can operate with the ones for lower numbered markers already operated. Only one MCA relay can be operated, however, at one time, due to the chain circuit arrangement at the MP relays, the one to operate corresponding to the lowest numbered MP relay operated.

The MCB, MCC and MCD relays to operate correspond to the MCA relay operated.

The marker connector relays operated as above connect the required leads from the marker in use on the call to the block relay frame and to other points.

Ground will also be connected to the NGF lead to the miscellaneous circuit for the terminating trouble indicator circuit to light the in-use lamp NGF.

A number group connector circuit HB relay, corresponding to the location of the required hundred block in the number group, operates.

There is a hundred block relay (HB) mounted on the block relay frame for each block of 100 numbers associated with a number group connector circuit. These relays are designated HB-0 to HB-7. The HB relay to operate is controlled by the operated FH and HN relays in the marker, which close ground through the winding of the marker circuit XHB relay to one of leads HB-0 to HB-24 to the number group connector by way of an HB punching of SD figure 3 and an NG-HB punching of SD figure 7. RM 517. OS 510

With this arrangement it is possible to have any one of the HB-0 to HB-7 relays connected to any one of the HB-0 to HB-24 leads. This is determined by the number of block relay frames or the portion thereof included in a number group. As for example; if a number group started at the fifth hundred on a block relay frame, the H~~G~~B-0 lead of the number group would be connected to the HB-4 relay of the block relay frame.

The marginal XHB relay, included in the operating path of the HB relay operates and sticks the circuit, if the required HB lead is crossed with some other HB lead. It is assumed for this call that no such trouble is encountered and that the XHB relay does not operate.

Leads HB-0 to HB-24 connecting contacts of the MCA relay to the windings of the HB relays is the cross-connection point, terminating at two sets of punchings (not shown) on the block relay frame. One of these sets of punchings is cabled to the MCA relay contacts and the other to the HB relay windings the required punchings in the two sets being cross-connected. This arrangement is provided to facilitate the transfer of a block of 100 numbers from one number group to another, if required by changes in traffic, in which case the winding of the associated HB relay would have to be disconnected from the HB lead of the number group connector circuit from which the numbers were moved and connected to an HB lead in another circuit corresponding to the new location.

The HB and TB relays and all the punchings except LS and NS shown on the circuit drawing for the number group connector, are located on the block relay frame, the LS and NS being located on the line distributing frame.

CHECK SIGNAL FROM NUMBER GROUP CONNECTOR CIRCUIT OS 510

When the number group connector circuit is seized, operation of its MP relay operates its MCA relay which connects ground to the CK lead to the marker, as a signal that the circuit is connected. The ground on the CK lead will operate the marker NK relay.

Operation of the NK relay causes the marker to seize the required incoming link and connector frame.

Marker circuit TE relay operates. OS 515

Marker circuit INB, HMT-1, TLH and NK-1 relays will operate as shown on SC 501. OS 503, 506 and 523.

The slow release TLH relay is used later in timing for the operation of the line hold magnet. The NK-1 relay is auxiliary to the NK relay.

The circuit to ionize the A ionic tube is opened. OS 519

With the marker normal, a path is closed for partial ionization of the A tube. This path is traced from the AC-DC power lead (ringing current) in figure 17-A, terminal 3 to terminal 1 of the CON repeat coil, normal contacts of the NK-1 relay, through the CON-2 resistance, the AN resistance, to terminal 1 of the tube, and from terminal 4 of the tube to ringing ground. This current is partially shunted by ringing ground at the CON-3 resistance, closed through the 8-5 winding of the CON repeat coil and the CON-1 resistance.

The A ionic tube and its associated equipment is provided for a crosspoint continuity test. The path described above is closed with the marker normal and until the NK-1 relay operates in order to keep the tube stabilized.

The marker circuit RT relay operates. OS 516 Sheet 3.

Operation of the RT relay, and the operations which it causes, are in preparation for the selection of a line junctor.

The punchings of SD figure 18 are cross-connected in accordance with the number of incoming frames or incoming groups equipped for the crossbar office. An incoming group consists of a pair of incoming link frames and their associated extension frames.

The cross-connections for various types of jobs are furnished in supplemental cross-connection sheets and are to be used as a guide while working with SD figure 18. If exactly 10 or 20 incoming frames are furnished, SD figure 18 is not required and "X" wiring is used at the PGT and OF-1 relays.

Assuming that figure 18 is to be used, the proper cross-connections are selected and with the marker normal, the RTA relay is operated and locked. Consequently, operation of the RT relay causes the SC operations shown on OS 516.

A JPN relay is operated when the normal junctor pattern is required (10 line junctors available), which is always the case in a first attempt to select a line junctor.

When the NK relay operated the XS-3 relay will release as shown on SC 501.

> Release of the XS-3 relay opens the paths used and releases the relays operated for the cross test of the NS leads, as follows: The XS-3 relay is slow release to allow sufficient time for the cross test to be made.
>
> The winding of the XS relay is also disconnected from the NS leads to the number group connector.

Marker circuit XS-4 relay releases and ground is disconnected from the NS lead required for the call.

Marker LE relays will release and the holding path of the INA relay is opened.

> The slow release INA relay starts to release. On this, a regular call, the release of the relay is not completed because the marker advances and provides a holding circuit again.

The L and XS-5 relays will now release.

> Release of the XS-5 relay causes the circuit to advance for the selection of the line. The XS-5 relay is slightly slow release to allow time for the operated L relay to release. This is necessary because the XS-5 relay normal closes a locking path for the L relays, and if the L relay used were allowed to lock at this time, a stuck circuit would result.

At this point in the call the following relays in the marker circuit are operated: CBR, CBS, AMB, recording relays as required, TMS-1, CK-4 to CK-10, RLT, INA, INB, OR, ALW, LTR, LLB, XS-1, XS-2, an FH relay, an HN relay, a TB relay, an even numbered HP relay, TEV or TOD, NK, NK-1, TLH, TE, HMT-1, RT, RTA, RTA', JGA and JPN.

In the number group connector circuit the required MP, MCA, MCB MCC, MCD and HB relays are operated.

SEIZURE OF INCOMING LINK AND CONNECTOR CIRCUIT

Seizure of the incoming link and connector circuit takes place after check of the number group connector by the operation of the NK relay. To keep the marker functions in a logical sequence, seizure of the incoming link and connector is discussed at this time as shown on SC 501.

The marker circuit NK relay, operating upon reception of the check signal from the number group connector circuit, causes the selection and advance of the required incoming link and connector circuit, as follows:

There is a start lead per incoming link and connector circuit per marker, these leads being designated ST-0 to ST-19 at the markers for the maximum of 20 incoming frames, or as required if less than 20 incoming frames are provided. One of these leads is selected for each call, under control of the F relays operated during the reception of the information from the sender. The number of the lead used is the same as the number of the incoming frame at which the calling trunk appears.

Each incoming link and connector circuit includes an MP relay for each marker and a corresponding set of E relays, for emergency use as described for the marker preference relays of the number group connector circuit.

The MP relay to operate is the one for the calling marker in the required incoming link and connector circuit, as determined by the operated F relays.

Each incoming link and connector circuit includes a marker connector relay MC for each marker. The MC relay to operate is the one associated with the operated MP relay.

Two or more MP relays can operate simultaneously. Additional MP relays can operate with the ones for lower numbered markers already operated. Only one MC relay can be operated, however, at one time, due to the chain circuit arrangement at the MP relays, the one to operate corresponding to the lowest numbered MP relay operated.

The MC relay operated as above connects the required leads from the marker in use on the call to the equipment on the incoming link and connector frame and to other points. The JP and JR leads are grounded to the terminating marker as shown on OS 516. These leads are used to assist the marker in selecting the required line junctors and junctor pattern relays at that time.

CHECK SIGNAL FROM INCOMING LINK AND CONNECTOR CIRCUIT OS 506

When the incoming link and connector circuit is seized, the operation of its MP and MC relays connects ground to the CK-1 and CK leads, respectively. The ground on the CK-1 lead is wired in a chain circuit at the MP relays for the terminating markers. Two or more MP relays can be operated but the one associated with the lowest numbered terminating marker returns the check signal and the others do not. Only one CK lead can be grounded because only the MC relay associated with the preferred terminating marker can operate. The MC relay operating path is also in a chain circuit through the MP relays.

Ground on these leads operate the marker IK and IK-1 relays as a signal to the marker that the circuit is connected.

Battery is connected to the windings of the HMT relay. This causes the HMT relay to make on its back contact if it is not already there.

> The HMT relay is a non-biased polarized relay connected differentially. Opposing windings are energized at this time, the release winding being stronger than the operate winding.
>
> Upon seizure of the marker, the armature of this relay may be in any position. It is caused to close and hold its back contact as above in preparation for use later in the call in timing for the release of hold magnets. The AF resistances are provided so that this time period may be changed if desired.

Marker circuit GT relay operates. OS 509 506

The GT relay serves no useful function at this time, but will be used later on in connection with ground test of the subscribers' line.

OS 509-1

The incoming trunk circuit F relay will operate by ground being connected to the FC lead through the terminating sender and sender link.

IF INCOMING TRUNK ASSOCIATED WITH 160 INCOMING LINK FRAME

Each incoming link frame serves a maximum of one hundred and sixty incoming trunks which are divided into ten groups of sixteen trunks, each group connecting to one of the ten primary switches on the incoming link frame. On the crosspoints of the upper eight levels of the primary switch, levels 2 to 9, inclusive, known as non-discriminating levels, are equipped with six contacts each. Two trunks, designated even and odd, are wired to the crosspoints of each of these eight upper levels. The primary switch in this manner accomodates a total of sixteen trunks. The crosspoints 0 and 1 levels, known as the discriminating levels, are equipped with three contacts each. These crosspoints are used to provide a switching means for closing through the proper trunk, either even or odd of the pair connected to any of the 2 to 9 levels, inclusive, to the link extending to the secondary switch.

The incoming link spread is exactly the same as that of the District link frame, that is, vertical to horizontal spread.

Primary vertical No. = Secondary Switch No.
Primary Switch No. = Secondary Horizontal No.

The links are also split left and right.

Incoming link and connector circuit PS-0 or PS-1 select magnet operates.

> The PS-0 select magnet operates if the trunk is located in the left side of the level or the PS-1 select magnet operates if the trunk is located in the right side of the level, when viewed from the front of the frame.
>
> Operation of the F relay in the incoming trunk circuit, in turn connects ground to an LC lead to the incoming link and connector circuit.

There are 10 LC relays in the incoming link and connector circuit, each associated with the incoming trunks and the links appearing in one of the primary switches 0 to 9. The LC relay to operate from ground on the ~~FC~~ LC lead is the one associated with the switch at which the calling trunk appears.

The sleeve leads of the incoming links accessible to the calling trunk are connected to the marker.

There are 10 left and 10 right incoming links wired to the verticals of each primary switch. The sleeve leads of these links, designated 0L and 9L and 0R to 9R, are connected to the marker in preparation for channel testing. OS 516

IF INCOMING TRUNK ASSOCIATED WITH 100-TYPE INCOMING LINK FRAME

If the incoming trunk was associated with a 100-type incoming link frame the trunk F relay would only operate the LC relay on the frame. OS 509 is shown for a 160-type incoming link frame only.

Full selector, manual, and toll incoming trunks may appear at the same incoming link and connector frame. However, the 10 trunks associated with one primary switch must all be of the same type. In the incoming link and connector circuit, the CL punchings at all of the LC relays for primary switches having full selector trunks are strapped, the first and last of these terminals being connected, respectively, to the FS and FS-1 terminals at the MC relays. This causes the operation of the marker circuit FS relay as above, when the required LC relay operates, as an indication that the call is a full selector call. Paths involving both the FS and FS-1 terminals are used to reduce the probability of trouble due to open circuits.

In a similar manner, the CL punchings at LC relays associated with manual incoming trunks are strapped and connected to the MAN and MAN-1 punchings, and those associated with toll incoming trunks are connected to the TOL and TOL-1 punchings, to provide to the marker the manual and toll trunk indications, respectively.

SELECTION OF TWENTY BLOCK RELAY

With the required even numbered HP relay in the marker operated, as a result of numerical translation, release of the XS-5 relay causes a block of 20 lines to be selected by the operation of the TB relay in the number group connector circuit. OS 510

There is a twenty block TB relay mounted on the block relay frame for each block of 20 numbers associated with a number group connector circuit. The TB relay to operate is the one for the twenty block which contains the called number as controlled by the operated HB relay and by the selection of one of leads TB-0 to 4 in the marker by the even numbered HP relay operated.

The marginal XTB relay in the marker is included in this path. It operates and sticks the circuit, if the required TB lead is crossed with some other TB lead. It is assumed for this call that no such trouble is encountered and that the XTB relay does not operate.

Leads TB-0 to TB-4 connecting contacts of the number group connector circuit MCA relay to the armatures of the HB relays are cross-connectible, terminating at two sets of punchings on the block relay frame. One of these sets of punchings is cabled to the MCA relay contacts and the other to the HB relay contacts, the required punchings in the two sets being cross-connected, (not shown). This arrangement is provided to facilitate the transfer of the five TB leads of a hundred block from one number group connector circuit to another, in case changes in traffic should necessitate the movement of a block of 100 numbers to a different number group.

The punchings included in the TB leads between the HB relay contacts and the TB relay windings are provided so that non-consecutive twenty blocks may be included in the same terminal hunting group, as described later. Except for this condition, numerically corresponding leads are cross-connected at this point.

INDICATIONS PROVIDED BY THE TWENTY BLOCK (TB) RELAYS OS 511, RM 509

The TB relays on the block relay frame are multi-contact relays, each of which is arranged to close three leads for each of the 20 numbers which it represents. These are the NS, NF and NC leads, the NS lead being used for the busy test of the line. The NF lead for indicating to the marker the type of the line (direct, terminal hunting or party) and the number of the line choice in which it is contained. The NC lead to indicate the "quarter-choice," or line link frame of the line choice, and the horizontal group or switch of the line link frame.

The 20 NS leads, the 20 NF leads and the 20 NC leads provided for these indications are numbered from 0 to 19 in each case, to correspond with the location of the numbers in the twenty blocks. They are wired from each marker to the number group connector circuits, where they are strapped, and due to operation of the marker connector relays in the required number group connector and the operation of the required twenty block relay are closed to punchings on the line distributing frame and on the block relay frame. These punchings are individual to the 20 numbers in the selected twenty block, those for each number being cross-connectible, to provide the required information. The strapping of these leads at the marker connector relays and at the twenty block relays makes it possible to connect the common leads from any marker to the individual leads of any block of twenty numbers in the office.

The numbers of a twenty block can be indicated to the marker by one group of numbers 0 to 19. The following chart shows each of the five numbers that will control the 0 to 19 indication in the marker.

Marker Indication	TB0	TB1	TB2	TB3	TB4
0	00	20	40	60	80
1 to 4	01 to 04	21 to 24	41 to 44	61 to 64	81 to 84
5	05	25	45	65	85
6 to 9	06 to 09	26 to 29	46 to 49	66 to 69	86 to 89
10	10	30	50	70	90
11 to 14	11 to 14	31 to 34	51 to 54	71 to 74	91 to 94
15	15	35	55	75	95
16 to 19	16 to 19	36 to 39	56 to 59	76 to 79	96 to 99

The NS leads, connected from the marker through contacts of the operated MCB and TB relays, are cabled to S terminals at vertical terminal strips on the line distributing frame, these terminals being designated according to line numbers, in numerical order. From this point the cross-connections required by the location of the line equipment are connected to the horizontal terminal strips which are designated by equipment numbers and cabled to the line link primary verticals. The numerical equipment designation at this point consists of four or five digits for each line link primary vertical of which the first two or three digits represent the number of the column, the third or fourth the number of the primary switch and the fourth or fifth the vertical number. The columns into which the line link primary switches are divided are numbered consecutively, throughout the line link frames, starting at 00.

The NF leads, connected from the marker through contacts of the operated MCB and TB relays, terminate at NF punchings on the block relay frame. These punchings are designated in numerical order, according to line numbers and are arranged for cross-connection to HF-0 to 19, RF0 to 19 or to TF0 to 19 punchings, shown on the print at contacts of the MCB and MCC relays, respectively and located on the block relay frame. Each NF punching is cross-connected to an HF punching if the associated line is a terminal hunting line other than the last line of a group, or to an RF punching if it is a direct line or the ring party of a party line and to a TF punching if a tip party line, the numerical designation of the punching being the same as the number of the line choice in which the line is located. With this arrangement, the closure of an NF lead to an HF, RF or TF punching, and consequently to a correspondingly designated lead to the marker, provides means for indicating to the marker the class of the called line and the number of the line choice in which it is contained.

Punchings and leads HF, RF and TF 0 to 19 for the maximum of 20 line choices are not always used on the block relay frame in all installations, the number of punchings needed being controlled by the number of line choices required for the office. As for example: if an office only required a maximum of 10 line choices 10 HF and 10 RF indications could be put in each of the standard HF and RF fields. This shortens the cross-connections since with this arrangement it is not necessary to cross the TF field for an HF or RF cross-connection.

In a similar manner, the NC leads, connected from the marker through contacts of the operated MCD and TB relays, terminate at NC punchings on the block relay frame. These punchings are designated in numerical order, according to line numbers, and are arranged for cross-connection to the 40 HG punchings designated A-0 to D-9, shown on the print at contacts of the MCD relay. These HG punchings represent quarter-choices and horizontal groups, the A, B, C and D designations indicating respectively the quarter choice or the first, second, third and fourth line link frames of a line choice, and the numerical designation indicating horizontal groups or switch 0 to 9. Each NC punching (except for certain cases described later) is cross-connected to one of punchings HGA-0 to HGD-9, the one used corresponding to the quarter-choice and horizontal group which contain the called line. Consequently, the closure of an NC lead to an HG punching and to the correspondingly designated lead to the marker provides means for indicating this information.

The strapping of the HF, RF, TF and HG leads, shown between the corresponding punchings and contacts of the marker connector relays, provides for the connection of these leads to any one of the markers.

The cross-connecting arrangement described above, together with tip and ring cross-connections at the main distributing frame, makes it possible to assign any line link primary switch vertical in the office to any line number. This is done by cross-connecting, as required, the T and R leads at the main distributing frame, the S (and M) leads at the line distributing frame, and the NF and NC punchings for the number at the block relay frame. Such an assignment may be changed, without affecting the line number, by changing these cross-connections. Furthermore, the lines of a terminal hunting group may be distributed over any or all of the line link frames, if desired for traffic reasons or to reduce service hazards.

After the TB and TBW relay operates the marker S relays, corresponding to busy lines in the selected twenty block operate.

> There are 20 sets of S and L relays in the marker designated 0 to 19, for use in testing the correspondingly located lines in the twenty block connected by operation of a TB relay. The marker is arranged to make a busy test on the 20 lines of the selected twenty block on each call, but on a call to a direct line it disregards the result of this test for the 19 lines other than the called line. Twenty lines are tested at one time in order to reduce marker holding time on calls to terminal hunting groups.
>
> It is assumed in this case that the called line is idle and that the corresponding S relay did not operate.
>
> The TBK relay operates as a check of twenty block indication.

CALLED LINE IDLE OS 503, 511

The marker circuit functions as shown on SC 501 up to the operation of the LE-1 to LE-6, LE-8 and LE-9 relays.

Ground is connected to the HF leads to the number group connector circuit.

> The HT relays are connected to the NF leads and ground is connected to the HF leads in order to operate HT relays for all the lines in the twenty block that are arranged for terminal hunting. The NF and HF leads for such lines are connected at the block relay frame. For this call it is assumed that the selected twenty block contains direct lines only, and, therefore, that no HT relays operate.

A holding path for the INA relay is provided. OS 523

> The operating path of the INA relay was opened when the INB relay operated and its holding path is opened on the first release of the LE-7 relay. The time interval between the first release of the LE-7 and its reoperation is so short, that combined with the slow release characteristics of the INA relay insures the INA remaining operated.

Marker circuit LE relay operates.

Operation of the LE relay checks the operation of all of relays LE-1 to LE-6, LE-8 to LE-11, and the connection of ground to all of the HF leads.

The TLT relay is made slow operate by condenser timing to allow sufficient time for the required TB relay, and the S relays for busy lines, to operate before proceeding with the selection of the line.

Operation of the RLT relay connected battery and ground to the differential TLT relay, causing it to close its back contact. Operation of the LE relay removes a short-circuit from the P condenser. Battery through the release winding of the TLT relay then charges the condenser, this charging current holding the relay normal. As the condenser becomes charged, this current decreases until the effect of the operate winding is stronger than that of the release winding, thus causing the relay to operate.

A marker circuit L relay, corresponding to the location of the called number in the twenty block, operates and locks. OS 510

The L relay to operate is determined by the units registration and whichever of relays TEV and TOD are operated. It operates only if the called line is idle, as indicated by the corresponding S relay being normal.

The operating path of the L relay as shown on OS 510 goes through the operated S relay contacts 1 and 2 top. The S contacts shown should be normal. This will be shown normal on later issues of this OS.

Ground is connected to the NF and NC leads to the number group connector circuit, which corresponds to the L relay operated. OS 511

These grounds are used to record in the marker the location of the called line, as identified by operation of its corresponding L relay.

The winding of the SG relay is connected to the NS lead to the number group connector circuit.

The SG relay is provided for a sleeve guard test on the line, and is connected to the NS lead, and consequently to the sleeve lead of the line, for this purpose from the time the line is tested as above until the line link primary hold magnet is operated. If, during this interval, a line which previously tested idle should become busy, the SG relay would operate, causing operations given later. This feature is necessary because an originating call does not ground the sleeve of the calling line until after the subscriber's sender has been seized, and a terminating call does not lock out originating calls in a line link group until after the line test has been completed. It is evident, therefore, that there is an unguarded interval in which the terminating marker may select a line which appears to be idle, but which is actually busy and will ultimately appear so.

The marker circuit LE, and INA relays release.

> The reason for the slow release feature of the INA relays will be discussed under intercepted lines.

The TLT relay releases because its release winding (secondary), which is stronger than its operate winding, is energized by release of the LE relay.

RECORDING TYPE OF LINE AND THE LINE CHOICE

A marker circuit LC relay, corresponding to the line choice which contains the called line, operates.

> The marker circuit includes a maximum of 20 LC relays, designated 0 to 19 or as required, one being provided for each line choice in the office. The one required operates from battery through the marginal XF and XF-2 relays, winding of the LC relay, over the RF lead (for a direct line) to the number group connector circuit, through operated marker connector relays to the block relay frame, over a cross-connection to the NF punchings for the called number, through operated contacts of the twenty block relay and the marker connector relays to the corresponding NF lead to the marker, and to ground at contacts of the operated L relay. The XF-2 relay operates and sticks the circuit, if two or more LC relay windings are included in the circuit.
>
> The XF relay non-operates on 3 LC relay windings and operates on 9 or more. The XF relay protects against excessive current through the LC relay windings from operating the AJ fuse. Between 3 and 9 LC windings the circuit is not positive on operate and non-operate current.

A marker circuit RF relay operates.

A marker circuit LCA relay corresponding to the LC relay used, operates.

> The LC punchings at each LC relay is cross-connected to the LCA punchings of the required LCA relay.

SEIZURE OF LINE CHOICE CONNECTOR CIRCUIT OS 512

Release of the LE-7 relay, with an LC and the IK-1 relays operated, cause the selection and advance of the corresponding line choice connector circuit.

> There is a start lead per line choice connector circuit per marker, these leads being designated ST-0 to ST-19 at the markers for the maximum of 20 line choice connector circuits, or as required if less are provided.
>
> Each line choice connector circuit includes an MP relay for each marker, wired as shown in SD figures 2A, 2B and 2C, and a corresponding set of E relays for emergency use.

The MP relay to operate is the one for the calling marker in the required line choice connector circuit, as determined by the cross-connection between the NF punching for the called number and one of punchings RF-0 to 19 at the block relay frame. OS 511

The operated MP relay locks, unless it is the one for the last marker.

Each line choice connector circuit includes marker connnector relays MCA, MCB and MCC for each marker. The MCA relay to operate is the one associated with the operated MP relay.

Two or more MP relays can operate simultaneously. Additional MP relays can operate with the ones for lower numbered markers already operated. Only one MCA relay can be operated, however, at one time, due to the chain circuit arrangement at the MP relays.

The MCB and MCC relays to operate correspond to the MCA relay operated. The marker connector relays operated as above connect the required leads from the marker in use on the call to the line junctor connector relays, to the line link frames of the choice, and to other points.

CHECK SIGNAL FROM LINE CHOICE CONNECTOR CIRCUIT

The line choice connector circuit MCA relay in operating connects ground to the CK lead to the marker, as a signal that the marker is connected to the line choice connector circuit. The ground on the CK lead will operate the marker LK relay which will cause the armature of the BA relay to make with its back contact and operate the LK-1 relay.

The BA relay is a non-biased polarized relay connected differentially. Opposing windings are energized at this time, the release winding (secondary) being stronger than the operate winding. This is done to prepare the relay to be used to test the sleeve of the selected incoming link.

The TMS relays will operate and release to recycle the time measure circuit.

WHEN OFFICE INCLUDES 100 AND 160 TRUNK INCOMING LINK FRAMES OS 513

Incoming link and connector circuit primary select magnet for the calling trunk operates.

The operation of the incoming link primary select magnet at this time will occur in offices having a combination of 100 trunk and 160 trunk incoming link frames or in offices with only 160 trunk incoming link frames.

In offices where only 100 trunk incoming link frames are used, the primary select magnet does not operate at this time.

In the combination offices one of the 0 to 9 or the 2 to 9 primary select magnets operate, depending upon whether the call involves a 100 trunk or 160 trunk incoming link, respectively.

The marker places battery on the B lead to the 8 or 10 primary select magnets in parallel for one switch and the previously operated F relay furnished the ground to operate the one for its proper level.

The polarized XPS relay is included in this path but does not operate unless two or more windings of primary select magnets are crossed or grounded. If it operates, due to trouble, it blocks the call.

WHEN 160 TRUNK INCOMING LINK FRAME IS CONNECTED

Marker circuit FS relay operates. OS 513

From ground on the FS lead from the incoming link and connector circuit.

Full selector, manual and toll incoming trunks may appear at the same incoming link and connector frame. However, the two trunks associated with one level within a primary switch must be of the same type.

This requires that the CL2 to CL9 punchings associated with the 2 to 9 primary select magnets be strapped to the FS, TOL or MAN punching in accordance with the termination of the two trunks in each level.. In addition, the PT2 to PT9 punchings must be strapped to the IP punching and "I" wiring used. The purpose of the IP, IT and IPT punchings is to indicate either physical or theoretical numbers within the same number series.

For the purpose of this call it will be assumed that there is no theoretical office involved.

RECORDING THE LINE LINK FRAME AND HORIZONTAL GROUP INDICATION

During the selection of the line choice connector circuit as above, the line link frame in the line choice and the horizontal group required are recorded in the marker as follows, due to operation of the L relay:

The marker includes 10 CA and 10 CB relays, designated 0 to 9, used to record half-choice and horizontal group indications, and to control auxiliary relays for recording quarter choice indications.

A CA relay is used if the information returned by the number group connector circuit indicates that the called line is located in one of the first two line link frame (a half-choice) of the line choice. A CB relay is used if it is in the third or fourth line link frame (B half-choice) of the line choice. In either case the numerical designation of the relay is the same as the number of the required horizontal group on the line link frame, as indicated by the NC cross-connection on the block relay frame. This is accomplished by the termination of HG leads A0 to A9 and B0 to B9 from the block relay frame through the number group connector to windings of the 10 correspondingly numbered CA relays, and HG leads C0 to C9 and D0 to D9 at the 10 correspondingly numbered CB relays.

The operating path for the CA or CB relay is traced from battery through the marginal XC relay, through the winding of the required CA or CB relay, over an HG lead to the number group connector circuit, through the MCD relay operated to the HG field of the block relay frame, a cross-connection to the NC punching for the called number, through operated contacts of the twenty block relay and the MCD relay of the number group connector to the corresponding NC lead to the marker and to ground at contacts of the operated L relay. The XC relay operates and sticks the circuit if the HG lead used is crossed with another HG lead.

The CA or CB relay operated extends its operating ground to one of relays LLG-A to LLG-D, to record the line link frame, of the four frames in the selected line choice, on which the called line is located. A CA relay, if operated over one of HG leads A0 to A9, causes the operation of the LLG-A relay, and if operated over an HG lead B0 to B9, causes the LLG-B relay to operate. In a similar manner, a CB relay, operated by ground on an HG-C or an HG-D relay, respectively.

The LLG relay operated connects ground to its corresponding LR lead, which is closed through the line choice connector circuit and terminates at the line link frame on which the called line is located. The purpose of this closure is to release the line link controller circuit and permit the terminating marker to seize it, if it should be delayed on an originating call because of an all senders busy condition or an all districts busy condition.

Marker circuit LLGE relay operates.

SELECTION OF A CHANNEL

RELAYS AND MAGNETS OPERATED

At this point in the call the following relays in the marker circuit are operated: CBR, CBS, AMB, recording relays as required, CK-4, to CK-10, RLT, OR, ALW, LTR, LLB, XS-1, XS-2, an FH relay, an HN relay, a TB relay, an even numbered HP relay, TEV or TOD, NK, NK-1, INB, TLH, TE, HMT-1, RT, RTA, RTA', GT, JGA, JPN, IK, IK-1, TBW, FS, TBK, RF, LK, LK-1, TMS-2, TMS-3, S relays for busy lines, an L relay, the required CA or CB relay, and the required LC, LCA, and LLG relays.

In the number group connector circuit the required MP, MCA, MCB, MCC, MCD, HB and TB relays are operated.

In the incoming link and connector circuit the required MP, MC and LC relays are operated. In addition, if the frame is a 100 trunk type frame, one PS-0 to PS-9 select magnet is operated. If the frame is a 160 trunk type, a PS-0 or PS-1 select magnet plus a PS-2 to PS-9 select magnet, are operated.

In the line choice connector circuit the required MP, MCA, MCB and MCC relays are operated.

In the incoming trunk circuit the D and F relay is operated.

TESTING THE INCOMING LINKS

Operation of the required LLG relay, causes 10 incoming links (10 left or 10 right) to be connected to the marker for test as follows. These 10 links connect the primary switch on which the calling trunk appears to the 10 secondary or extension switches.

The HCA relay is used if the called line is in half-choice "A", as indicated by operation of the LLG-A or LLG-B relay. If the line is in half-choice "B", the HCB relay operates, due to operation of the LLG-C or LLG-D relay.

The LIL and RIL relays are used to connect the sleeve leads, of left or right incoming links respectively, to the marker channel testing relays. Terminals LIL and RIL of figure 15 are cross-connected to terminals IL-0 to IL-9 of figure 18, as indicated in the pattern cross-connection data. These cross-connections are arranged in accordance with the size of the installation. When junctors from the left half of the incoming secondary switches are used, left incoming links will be used, and when junctors from the right half of the incoming secondary switch are used, right incoming links will be used.

When incoming link extension frames are used, left incoming links are used with the incoming secondary switches and right incoming links with the extension switches.

On first attempt to select a channel left links and junctors are always used if the called line is in half-choice "A". Right links and junctors are used if the called line is in half-choice "B". Consequently in any installation terminal IL-0 is cross-connected to terminal LIL and terminal IL-1 is cross-connected to terminal RIL. In this manner the LIL relay is operated if the HCA relay is operated and the RIL relay if the HCB relay is operated.

Junctors tested on the first attempt will be known as the "A" junctor group. Subsequent junctor groups will be explained in detail later.

Marker circuit AB relays, corresponding to busy incoming links, operate from the make busy ground (not shown) on the sleeves of the links, closed to the marker over leads 0L to 9L or 0R to 9R.

> Operation of the required incoming link circuit LC relay connected to the marker the sleeve leads of the 10 left and 10 right incoming links which are accessible to the calling trunk. The LIL or RIL relay operated connects these leads for either the left links or the right links, as required, to the windings of the AB relays and 10 LL relays, used for testing a maximum of 10 channels on any one attempt.

TESTING THE LINE JUNCTORS

Each line choice connector circuit includes 10 LJA relays, designated 0 to 9, and 10 LJB relays, also designated 0 to 9, used to connect line junctor sleeve leads and their corresponding hold magnet leads between the marker and the line link frames of the line choice. Each of these relays is associated with 10 line junctors, the LJA relays being used with the 100 line junctors which terminate at the line link frames of the "A" half-choice, and the 10 LJB relays being used with the 100 junctors which terminate at the frames of the "B" half choice.

The marker circuit includes 10 JA relays, designated 0 to 9, and 10 JB relays, also designated 0 to 9, used respectively to control the operation of the correspondingly numbered LJA and LJB relays in the line choice connector circuit. However, on the subsequent junctor group (E junctor group) the operated JA or JB relay in the terminating marker may or may not operate a like numbered LJA or LJB relay in the line choice connector circuit. This condition will be covered later.

In any installation, on a first attempt to select a channel, (A junctor group) 10 channels are connected to the terminating marker for test. In this case, the line junctors involved are wired in the numerical relation previously given, namely, that the line link secondary vertical number is the same as the number of the incoming frame or group at which the associated junctor originates, and the incoming secondary or extension vertical number is the same as the number of the line choice to which the junctor is connected. Also, the assignment of these junctors to LJA and LJB relays is such that the numerical designation of the relay is the same as the number of the incoming frame or group at which the junctors originate, and consequently is the same as the number of the line link secondary verticals, in each switch to which they are connected.

The incoming frame used for the call controls the selection of the required line junctors by connecting ground to the JR lead to the marker upon operation of the incoming link circuit MC relay, previously given. There is one JR lead per incoming frame or group bearing the same number as the frame or group. The terminating marker is arranged to work with a maximum of 10 incoming frames or groups. Therefore, the terminating marker has 10 JR leads, designated 0 to 9, appearing in it. The JR-0 to JR-8 leads of this group terminate at the JGA to JGE relays in figure 18. Since the JGA relay has been operated the JR-0 to 8 leads are connected to the JGA-0 to 8 punchings. Punchings JGA-0 to 8, up to the number of incoming frames or groups equipped for the job are cross-connected to correspondingly numbered JR-0 to 8 punchings at the HCA and HCB relays. It is not necessary to terminate the JR-9 lead at the JGA relay. This lead is terminated directly on the JR-9 punching. Some or all of the JR punchings which were not cross-connected due to the number of incoming frames or groups being less than 10 will be cross-connected and used as described later.

With the cross-connections made and with ground connected to the JR lead of the same number as the incoming frame or group involved, operation of the HCA or HCB relay causes the required line junctors to be connected for test as follows:

A JA relay is operated at this time if the called line is in an "A" half choice, as indicated by the HCA relay operated; otherwise a JB relay operates due to the HCB relay being operated. The numerical designation of the relay is the same as the number of the incoming frame or group on which the calling trunk appears.

A line choice connector circuit LJA or LJB relay operates due to the connection of battery to the corresponding JA or JB lead by operation of a marker circuit JA or JB relay, respectively.

> The LJA or LJB relay to operate corresponds in number to the JA or JB relay operated.
>
> Punchings JA-0 to 9 and JB-0 to 9 at the line choice connector circuit MCC relay and the correspondingly designated punchings at the windings of the LJA and LJB relays are cross-connectible. For first choice line junctors these punchings are strapped number to number, up to the number corresponding to the highest incoming frame or group equipped. The remaining punchings, if any, will vary in their strapping for certain combinations of incoming and line link frames. The LJA and LJB relays, while they are shown on the circuit drawing for the line choice connector circuit, are mounted on the line junctor connector frame.
>
> The marker is arranged to prevent the operation of any LJA or LJB relays, and consequently to prevent the completion of the call, in case the JA or JB lead required for the call is crossed with some other JA or JB lead. Under these conditions, in order to prevent the operation of two or more LJA or LJB relays, and the consequent connection to the marker for test of two or more groups of line junctors, ground is connected through normal contacts of the JA and JB relays to all of the JA and JB leads which are not required for the call. Consequently if the lead that is used for a call is crossed with any lead that is not used, the direct ground connection on the latter short-circuits the operating battery for the LJA and LJB relays and none of them operate. This causes the marker to time out and call in the trouble indicator.

LOCKOUT OF LINE LINK GROUP OS 512

Relays LOG-A to D have their windings connected, through contacts of the corresponding LLG relays, to the LO and LE leads A to D, respectively, to the line choice connector circuit. These leads are extended through the marker connector relays in the line choice connector circuit to the four line link frames of the selected line choice. At each line link frame they are closed through the windings of start circuit relays to battery, provided that the line link controller circuit is normal.

A marker LOG relay, corresponding to the operated LLG relay, and the line link start circuit LA and LB relays operate in series.

> These relays (LA and LB) lock out originating calls on the selected line link frame. There is no interference with originating calls on the other three line link frames of the line choice.

If the required line link frame is busy on an originating call, at this time, it holds the LO and LE leads open. This delays the operation of the marker circuit LOG relay until the originating call is completed. When the required LA or LB operates, during disconnection of the originating call, it will lock and operate the marker LOG relay in series. The LA or LB relay that was not required will operate when the line link start circuit FA or FB relay releases.

If the line link frame is delayed on an originating call because of an all senders busy condition or an all districts busy condition, it is released due to the connection of ground to the LR lead by operation of the LLG relay, as previously described. This permits the LOG relay to operate.

The LOG relays have two windings because the throw-over arrangement between the regular and the emergency start circuits of the line link frame does not transfer the lockout lead. Therefore, it is necessary for the marker to lockout both the regular and the emergency start circuits in all cases.

The cut-off arrangement in the line link start circuit is such that if an originating call starts at the time the LOG relay operates, the terminating call is given preference.

A marker circuit LG relay, corresponding to the LOG relay used, operates.

Ten SM leads, designated 0 to 9, are closed from the marker, through the line choice connector circuit, to the required line link frame.

These leads are closed only to the line link frame on which the called line is located. This is in preparation for operation of the required line link primary and secondary select magnets, given later.

The EH relay operates if the LG-A or C relay is operated, indicating the first frame of a half choice, and the OH relay operates if the LG-B or D relay is operated, indicating the second frame. The relay to operate extends the line link secondary hold magnet leads for the corresponding frame in the half choice to contacts of the CH relays in the channel testing circuit.

SELECTION OF LINE LINK HORIZONTAL GROUP OS 512

With the required LOG relay in the marker operated, the required horizontal group is selected.

The HG relay to operate, of the 40 HG relays in the four frames of the line choice, is selected by the operated CA-0 to 9 or CB-0 to 9 relay in the marker and by the operated LOG-A, B, C or D relay. The numerical designation of the CA or CB relay corresponds to the horizontal group which contains the called line and the LOG relay indicates the frame, of the four in the line choice. The HG relay operates over an H lead between the line link and group control circuit and the line choice connector circuit, and over the required HG lead (A-0 to D-9) between the line choice connector circuit and the marker.

The SM leads are extended to the 10 primary select magnets and the 10 corresponding secondary select magnets for the ten links associated with the primary switch on which the called line is located.

These leads are closed to prepare for the operation of one primary and one secondary select magnet after the selection of a channel.

TESTING THE LINE LINKS

The 10 line links available for the call, connecting the 10 secondary switches to the required primary switch, are tested with the required marker circuit LOG relay operated:

Line choice connector circuit CR and CE relays for the required line link frame operate in parallel, from ground on the CCA, B, C or D lead from the marker, due to operation of the required LOG relay.

> Each line choice connector circuit includes a CR relay and a CE relay for each of the four line link frames of the choice. These relays are mounted on the line junctor connector frame. Two relays are provided with their windings and contacts multipled to prevent service interruptions in case an open winding or other trouble should occur which would require that a relay be changed.

Ground is connected to the PC leads to the traffic register circuits for the line link horizontal group and line choice connector circuits.

> Ground connected to the PC lead of the line choice connector to traffic register circuit is used to operate a register which records the number of calls made to the line link frame. The PC lead to the line link horizontal group circuit is also grounded. Depending upon the wiring of the line link circuit, this ground may be used to operate a register through contacts of the operated HG relay, which records the number of calls made to the horizontal group.

Marker circuit LL relays, corresponding to busy line links, operate from the make busy ground on the sleeves of the links from district junctors or incoming trunks, closed to the marker over the LL-0 to 9 leads. OS 514

> The marker includes 10 LL relays, designated 0 to 9, used with the AB relays for testing the line link parts of 10 channels.

RINGING CONTROL OS 517

Operation of the required LOG relay causes the marker to prepare the incoming trunk circuit for ringing the called station, as follows:

Marker circuit RC relay operates due to operation of an LOG relay with the RF relay operated.

> The path to operate the RC relay is traced through normal contacts BB relay, operated contacts LOG - and RF relays, normal contacts SGA, JF-0 to JF-4, BBT, YB and CK-1 relays, operated contacts CK-4 relay to ground.

Marker circuit RC-1 and incoming circuit RC relays operate in parallel.

> The RC lead is closed through the incoming link and connector circuit to the incoming trunk circuit. Ground connected to it operates relay RC in the trunk circuit which extends its locking ground back to the marker. Later in the call the marker will test for the proper operation of the trunk relay by removing its operating ground and determining whether or not the RC-1 relay is held operated by ground from the trunk circuit.

MATE FRAME LOCKOUT OS 513

In offices having incoming extension frames the line junctors are multipled at two incoming frames or two extension frames. The two frames of each pair associated in this manner are arranged for mate operation with respect to the control of the secondary select magnets and the closure of a channel.

This is necessary in order to prevent interference in operating select and hold magnets on calls involving the two incoming frames of a pair simultaneously. The marker preference relays in the incoming link and connector circuit are effective to prevent the simultaneous connection of two markers to one frame, but do not prevent seizure of the mate frame by another marker. Simultaneous calls of this kind are permitted to progress. At this point, however, the marker makes a frame preference test on the incoming frame and proceeds with the call only if the mate incoming frame is idle or is engaged on a call but has not yet operated its secondary select magnets. If the secondary select magnets on the mate frame are operated, the call on the home frame is delayed until such time as they are released. The operation is as follows:

Incoming link FP relay operates.

> In offices having incoming extension frames, circuits per figure 8 and 10 are provided for each even numbered incoming frame and a circuit per figure 9 for each odd numbered frame. The FP relay to operate is the one on the frame to which the marker is connected, as controlled by the marker connector relay operated.

The operated FP relay locks, if it is the one on the even frame of the pair.

The operating path for the FP relay on the even frame is opened, if the FP relay that operated is the one on the odd frame.

Incoming link RS relay operates.

> The RS relay to operate corresponds to the FP relay operated. The ground to operate the RS relays is arranged in a chain, so that in case of simultaneous connection of battery to the MPS leads of both frames, operating both FP relays, the RS relay for the even frame would operate and the one for the odd frame would not. This chain circuit also prevents operation of the RS relay on the odd frame if its FP relay should operate after the FP relay on the even frame operated.

The battery to operate the RS relay is supplied by the marker to prevent a false ground on the winding of one of these relays from operating the relay and to reduce the possibility of setting up double connections.

If the incoming frames operate as individual frames, figure 11 of the incoming link circuit will be used and battery on the MPS lead will operate the RS relay directly and the RSM lead will not be used.

The ten secondary select magnets to operate are located one in each switch, and are of the same number as the primary switch on which the calling trunk appears. The magnets that operate are determined by the LC relay, of the 10 LC relays, that is operated.

If extension frames are provided, the corresponding select magnets on the incoming link secondary switches and on the associated extension switches are multipled and operate in parallel, so that either left or right links and junctors may be used, as required.

At this point the incoming link and connector circuit returns a check signal to its associated marker, permitting it to advance for channel test, and it also locks out the mate frame with respect to the operation of secondary select magnets.

The MK-0 relay operates from ground on MK-0 lead from the incoming link and connector circuit. Operation of this relay permits the marker to advance for channel test.

Ground connected to the MK-1 lead to the mate incoming frame has no effect if the frame is idle. If a marker is connected to it, however, this ground is closed through the operated marker connector relay and operates the MK-1 relay of the marker with which the mate frame is associated. With the MK-1 relay operated, the call is delayed at channel test until such time that the marker connected to the home frame removes battery from the MPS lead, which results in the release of the FP and RS relays and the operated select magnets, and the removal of ground from the MK-0 and 1 leads, respectively, to the associated marker and the mate incoming frame.

Operation of both the MK-0 and MK-1 relays in the same marker is an indication of trouble and in such a case the call is not allowed to progress.

CHECK OF LINK, JUNCTOR CONNECTOR, HORIZONTAL GROUP AND PATTERN RELAYS OS 514 and 516

Before proceeding with the selection of a channel, the marker makes a check to determine that the link and junctor connector relays have been operated, that the horizontal group has been selected and that the lead used for this purpose is not crossed, that a junctor pattern relay is operated or that a normal junctor pattern condition (10 junctors available) has been determined, and that the use of either left or right incoming links has been indicated.

If all these conditions have been met, the TK relay operates.

The K resistance in the line choice connector circuit provide margins for the XHG relay such that it does not operate unless two or more HG relays are operated or unless for some other reason the required BK lead between the K resistances and the line link and group control circuit is crossed with some other BK lead. If the XHG relay operates, it sticks the circuit. It is assumed for this call that it does not operate.

In the above circuit, two sets of contacts are used at the multi-contact LJA or LJB and LC relays in order to check the operation of both halves.

In the line choice connector circuit, two TK leads are provided between contacts of the MCA relays and contacts of the LJA and LJB relays. One of these leads connects the first SD figure 2 to the first SD figure 3 and the other connects the last SD figure 2 to the last SD figure 3. This is done to prevent trouble if an open should occur in the strapping of this lead at either set of relays.

For the same reason, the CK lead between the MCA relays and the CR and CE relays, the BK lead between the LJA and LJB relays and the K resistances, and the CK lead between the CR and CE relays and the line link and group control circuit are wired in a similar manner. The two CK leads to the line link and group control circuit terminate respectively at the first and last HG relays.

The AK lead connecting the MC and LC relays of the incoming link and connector circuit (and other common leads between these relays) are wired in a similar manner.

It is assumed that the required relays have been properly operated, and consequently a satisfactory check of these conditions is indicated by the operation of the marker TK and OVA relays.

The OVA relay will be used in connection with overflow in the "A" subgroup of line junctors.

SELECTION OF A CHANNEL OS 515

TKT relay operates.

The TKT relay is made slow operate by condenser timing, as described for the TLT relay, in order to allow sufficient time for the operation of the AB and LL relays corresponding to busy circuits.

The CH relays

In order for a CH relay to operate, the MK-0 relay must be operated and the MK-1 relay must be normal, indicating that the mate incoming frame is not being held, with secondary select magnets operated, by another marker. Otherwise, operation of the CH relay is delayed until the mate incoming frame is released and the MK-0 and 1 relays meet these conditions.

There are 10 CH relays in the marker, designated 0 to 9, used with corresponding AB and LL relays in selecting one of 10 channels. In order for a CH relay to operate, the corresponding AB and LL relays must be normal, indicating that the associated incoming link, line junctor, and line link are idle. Either or both of the AB and LL relays operated causes the corresponding CH relay to be passed by and the operating ground to be extended to the relays for the next channel.

The 10 channels tested connect the incoming link primary switch at which the trunk appears to be the line link primary switch containing the called line, by way of the 10 incoming link secondary switches and the 10 line link secondary switches.

The purpose of the IN, OT and other punchings involved in operating a CH relay is explained in RM 517, under "Order of Preference for Selecting a Channel."

The XSM relay.

The XSM relay is provided in order to stick the circuit in case a false ground is encountered on any of the 10 SM leads previously connected from the marker through the line choice connector circuit to the 10 select magnets of the primary line switch containing the called line. It is disconnected at this time from the lead to be used for the call, as indicated by the operation of a CH relay, to prepare for operating the required select magnet. It is assumed for this call that no false ground is encountered on these leads and that the XSM relay does not operate.

The TE relay releases.

The TE relay is fast release to prevent the false operation of an additional CH relay if an earlier choice channel should become idle at this time, releasing its AB or LL relay. The TE relay is fast release due to a minimum armature travel.

Incoming link primary select magnet for the calling trunk operates. (100 incoming trunk link only) OS 513

The marker places battery on the B lead to the 10 primary select magnets of one switch connected by the LC relay. The previously operated trunk F relay furnishes the ground to operate the select magnet for the proper trunk.

The line link primary and secondary select magnets for the selected channel operate. OS 512-2.
515-2.

The line link primary select magnet to operate, is in the primary switch whose HG relay is operated, and agrees in number with the CH relay operated. The secondary select magnet to operate, is in the switch whose number agrees with the CH relay operated, and agrees in number with the HG relay operated.

In line link frames having two or more bays of primary switches, corresponding select magnets are multipled and operate in parallel.

ORDER OF PREFERENCE FOR SELECTING A CHANNEL

The IN and OT terminals at the AB and LL relays are cross-connected to produce the same order of preference for selecting a channel as is used for cross-connecting the D, F, K and X terminals in the line link and group control circuit for selecting district junctors and line links. The S terminal is cross-connected to the IN terminal which corresponds to the first channel in the order of preference. The OT terminal is cross-connected to the succeeding IN terminal in the order of preference, except that the OT terminal for the fifth channel in the order is connected to the M terminal. The M-1 terminal is connected to the IN terminal of the sixth channel and the OT terminal for the last channel is connected to the E terminal. RM 517

In the crossbar system, each part of a channel is also a part of a number of other channels. For example, an incoming link, having access to a number of line junctors, each of which in turn has access to a number of line links, can be used with these junctors and links in a large number of combinations. The selection of an incoming link renders temporarily unavailable for service all of the combinations of which it is a part. The associated line junctors and line links, however, may still be used to form channels from other incoming link primary switches and from other incoming link frames. It is advisable to use them in this way in order to reduce "cover," which is the blocking of a complete channel by one part of it which is busy when other parts are idle.

The selection of line junctors and line links, in a similar manner, renders temporarily unavailable all of the particular combinations in which each is included, but does not prevent the other parts of these channels from being used in the formation of other combinations.

Successive terminating calls tend to be distributed over all of the incoming frames and over all of the line link frames. Consequently, with all of the terminating markers wired in the same way with respect to the starting point and the order of preference in selecting a channel, parts of channels which are made unavailable because other parts are busy are used whenever possible in completing calls from or to other frames. This method leaves available, in general, a number of complete channels from any incoming frame to any line link frame, which can be used in case of a momentary peak load at any point. These are the least preferred channels in the chain of preference. On the other hand, if a perfectly random distribution of calls were employed, although there would be as many idle links and junctors, these circuits could not be matched as efficiently.

A similar condition exists in the selection of an originating channel, consisting of a district link, an office junctor and an office link. All of the originating markers are arranged to prefer channels in the same order, to reduce cover.

There is no direct relation between the order of preference used in the originating markers and that used in the terminating markers. However, in view of the fact that line links are used both for originating and terminating traffic, the order of preference in selecting line links and district junctors on originating calls is made the same as that used for selecting channels in the terminating markers. This greatly reduces the probability of interference between originating and terminating calls due to cover.

The regular and reserve tests employed in the selection of a district junctor group assist in preventing the blocking of originating calls by leaving available at least one circuit, in the least preferred district junctor groups (except under extreme conditions) which can be used for an outgoing call even though several of the preferred groups can not be used because the connecting line links are busy on terminating calls.

The punchings for connecting the channel testing relays, in both the originating and terminating markers, and for determining the district junctor group preference in the line link and group control circuit are provided so that the point of greatest wear on the associated link switches may be distributed during the life of the office. They are connected initially as shown on the prints and for the first and succeeding changes as described in the circuit notes.

In both markers, the order of preference is changed on second trial calls in order to pick a different channel, in most cases, than the one used on the first trial and thus to increase the probability of completing the call in case the first trial failure was due to a trouble in the channel itself. This feature does not materially affect the efficiency of the arrangement described above.

CLOSURE OF CHANNEL CROSSPOINTS RM 8-10

At this point in the call the following relays in the marker circuit are operated: CBR, CBS, AMB, recording relays as required, CK-4, to CK-10, RLT, OR, ALW, LTR, LLB, XS-1, XS-2, and FH relay, an HN relay, a TB relay, an even numbered HP relay, TEV or TOD, NK-1, TLH, RMT-1, INB, RT, RTA, RTA', GT, JGA, JPN, IK, IK-1, TBW, FS, TBK, RF, LK, LK-1, TMS-2, TMS-3, S relays for busy lines, and L relay, the required CA or CB relay, the required LC, LCA, LCB, LLG, LLGE, LOG and LG relays, HCA or HCB, RC, LIL, or RIL, the required JA or JB relay, RC-1, EH or OH, AB relays corresponding to busy incoming links and line junctors, LL relays corresponding to busy line links, MK-0, TK, TKT, OVA, and a CH relay.

In the number group connector circuit the required MP, MCA, MCB, MCC, MCD, HB, and TB relays are operated.

In the incoming link and connector circuit the required MP, MC, LC, FP AND RS relays, a primary select magnet and 10 secondary select magnets are operated.

In the line choice connector circuit the required MP, MCA, MCB MCC, CR AND CE relays and the required LJA or LJB relay are operated.

In the line link and group controller circuit the required HG relay, a primary and a secondary select magnet and the LA and LB relays are operated.

In the incoming trunk the D, F, and RC relays are operated.

HOLD MAGNET TIMING

When a channel becomes idle by the removal of the make busy ground from the hold magnets and sleeve leads, an appreciable time is required to release the hold magnets fully and open the crosspoints. To avoid seizure of a circuit during this interval, and a possible double connection which might result, the condenser timed HMT relay is employed to introduce a slight delay between the selection of a channel and operation of the hold magnets.

The HMT relay is made slow operate by condenser timing and by means of the AF resistances. The resistances, by limiting the current flowing in the primary winding of the HMT relay, allow the M condenser to take on more of a charge before the primary winding can operate the relay. By connecting different resistances the operating time of the HMT relay can be varied.

Marker circuit HMT-1 relay releases.

LINK SLEEVE TEST AND FALSE CHARGE GUARD

Release of the HMT-1 relay connects windings of the BA and BC relays, respectively, to the sleeve leads of the selected incoming link and line link, indicated by the CH relay operated. Opposing windings of each of these relays have been energized, causing the armatures to close the back contacts in preparation for this test.

These relays are arranged to operate if battery through the winding of a hold magnet or an approximately equivalent resistance is encountered on the associated sleeve lead. The primary and secondary windings, in each case, are so proportioned that the relays do not operate if the battery is not present or if the sleeve lead is grounded.

It is assumed for this call that no trouble is encountered and that the circuit consequently advances as follows:

Marker circuit BA and BC operate. The current flow in the BA path is such that the incoming link primary hold magnet may or may not operate at this time.

When marker circuit BC-1 operates, battery is connected through the primary winding of the FCG relay to the RT lead to the incoming link and connector circuit.

> The FCG relay is used to guard against false charge conditions. Connection of battery through its primary winding to the RT lead, with ground closed through its secondary winding to the TT lead causes it to operate if any ground or battery condition is encountered on these leads that might cause a false charge. If the FCG relay operates, it sticks the circuit. It is assumed for this call that it does not operate.
>
> The TT and RT leads have been extended, at this point in the call, through the incoming link and connector circuit to the incoming trunk circuit. Operation of the incoming link primary and secondary hold magnets, and the line link secondary hold magnet, given below extends these leads up to the line link primary vertical, making the false charge test effective up to this point. OS 519

CLOSURE OF CHANNEL UP TO PRIMARY LINE LINK VERTICAL

With the above tests properly completed, the incoming link hold magnets and the line link secondary hold magnet corresponding to the selected channel will be operated along with the GJ relay. OS 518

> The operating ground for the GJ relay serves to lock the BA relay momentarily, until the GJ relay is fully operated.
>
> In offices having incoming groups, two incoming secondary switch hold magnets are operated in parallel and held during the conversation. These two magnets are associated with the selected line junctor and are located in corresponding positions on the secondary bays of the pair of incoming frames, or on the two extension frames. No interference is caused by the operation of the hold magnet not required for a particular call, as on that frame no select magnet has been operated. In offices not having extension frames, only one incoming secondary hold magnet is operated.
>
> The path to operate the incoming secondary hold magnets is traced over the corresponding LJ lead from the marker through the line choice connector circuit to the sleeve of the line junctor at the line link frame, and over this lead to the incoming link frame.
>
> The path to operate the line link secondary hold magnet is traced over an EH or OH lead, corresponding to the required half choice and the channel selected, between the marker and the line choice connector circuit, and over an HM lead to the line link frame.
>
> Operation of the hold magnets closes the crosspoints at the levels of the operated select magnets.

Operation of the line link secondary hold magnet, in closing the required crosspoint contacts, extends ground to the corresponding LL lead to the marker, as shown on SC 501 marker circuit GC, GC-1 operate and EH or OH release.

Operation of the incoming link secondary hold magnet, in closing the required crosspoint contacts, extends its operating ground to the sleeve of the incoming links.

The required incoming link primary hold magnet operates, if not already operated, and the marker circuit BA relay releases.

> The BA relay releases because its operate winding is short-circuited and its release winding is energized by the ground connected to the incoming link sleeve as above, which returns to the marker over the corresponding lead 0-L to 9-R.
>
> Release of the BA relay is a check that the sleeve contact of the secondary switch crosspoint is closed.

Operation of the incoming link primary hold magnet closes the crosspoint at the level of the operated select magnet. Closure of the sleeve contact of the crosspoint extends the ground used for operating the primary hold magnet to the S lead to the incoming trunk circuit. This lead has previously been connected in the trunk circuit to the SL lead through the incoming link and connector circuit to the marker. With ground connected to it as above.

Marker circuit SL and SL-1 operate.

The release of the BA relay checks for closure of the sleeve contact at the incoming link secondary switch, and operation of the BC relay indicates that the line link sleeve lead is closed to battery and not falsely grounded. In addition, the GC relay operated checks for closure of the sleeve contact at the line link secondary switch, and the SL relay operated indicates sleeve closure at the incoming link primary switch.

Consequently, operation of the SL-1 relay indicates proper closure of the sleeve lead from the trunk circuit up to the primary line switch vertical. However, it is possible that the incoming primary hold magnet operated at the same time that the marker circuit BA relay operated. This would cause premature operation of the SL relay. No interference would result because the SL-1 relay, on which the marker depends in order to advance, can not operate until the BA relay releases.

Marker circuit HG relay will operate due to SL-1 operated with FCG relay normal.
OS 519

Operation of the SL-1 relay also restores the incoming mate frame preference and lock-out circuit, permitting the mate incoming frame to operate select magnets, and it causes the line link primary hold magnet to be operated.

RELEASE OF MATE FRAME LOCKOUT

The FP and RS relays in the incoming link and connector circuit will release along with the incoming link secondary select magnets.

The RS in releasing will remove ground from MK-0 and MK-1 leads releasing the MK-0 in our marker and the MK-1 in another marker if its in the mate incoming frame. OS 513

CLOSURE OF CHANNEL TO THE CALLED LINE

Operation of the SL-1 relay opens the operating path of the TLH relay. This relay, however, is sufficiently slow release so that it remains operated until the line link primary hold magnet has operated.

When the GLH relay operates ground is removed from the RC lead to the incoming link and connector circuit.

> This ground was connected when the RC relay operated, to operate a ringing control relay in the incoming trunk circuit. The trunk circuit relay operated, locked and extended its locking ground back to the marker over the RC lead. The ground from the trunk circuit holds the marker circuit RC-1 relay as a check for proper operation of the trunk circuit relay. Release of the RC-1 relay at this time, due to a trouble, causes operations given later, it being assumed for this call that the RC-1 relay remains operated.

The winding of the SG relay is disconnected from the sleeve of the called line by the GLH relay operating.

> The SG relay is provided for a sleeve guard test, to prevent the marker from closing through to a line which tested idle but later became busy on an originating call. At this point in the call sufficient time has elapsed for this condition to be indicated. The SG relay winding is disconnected from the sleeve of the line in preparation for operation of the primary hold magnet.
>
> In addition, a line may appear as an individual line at one location in the number group connectors and also as a non-consecutive terminal hunting line at another location. This condition is described in detail later under terminal hunting. However, in such a case two markers might attempt to engage the line simultaneously. One of these calls would be delayed at the line choice connector circuit and when it eventually proceeded it would find the line busy. Under these conditions the sleeve guard test prevents the selection of the line on this call.
>
> Furthermore, subscribers' lines may be arranged for manual outgoing service and dial incoming service. Such lines are not made busy on an originating call until the operator answers. It is not desirable to complete a terminating call to a line having the receiver off the hook. The probability of the occurrence of this condition is reduced by maintenance of the sleeve guard test until just before the line hold magnet is operated.

The RT lead to the incoming link and connector circuit is disconnected from the winding of the FCG relay and connected to ground.

> Ground is connected to the RT lead to discharge the capacity of the RT and TT leads in preparation for the crosspoint continuity test. At this time the TT lead is maintained at ground potential through the ground winding of the FCG relay.

Positive battery, 110 volts, is connected through the windings of the CON and CON-3 relays to the No. 2 terminal of the A ionic tube. OS 519

> This closure is also in preparation for the crosspoint continuity test.

The required line link primary hold magnet operates and locks.

The path to operate the line link primary hold magnet is traced over an NS lead between the marker and the number group connector circuit, the lead used being determined by the L relay operated in the marker, and over the S lead of the line to which the NS lead has been connected by the operated twenty block relay. The path also includes the operated contacts of the marker TLH relay which, because of its slow release characteristic has not as yet released. Operation of the hold magnet closes the crosspoint at the level of the operated select magnet. The locking path of the line hold magnet is traced through the sleeve contact of the primary switch crosspoint, over the sleeve of the line link, through the sleeve contact of the secondary switch crosspoint to the corresponding LJ lead which is closed through the line choice connector circuit to ground in the marker. There is another parallel path over the LL lead which will also lock in the line link primary hold magnet.

The marker HG relay holds in parallel with the line link primary hold magnet.

With the operating path of the line relay opened, removal of the receiver to answer the call does not cause the originating equipment to function.

Operation of the SL-1 relay opens the operating path of the TLH relay. This relay is slow release to allow time for the operation of the line hold magnet. It is sufficiently slow release so that it remains operated until after all of the above functions have taken place.

Release of the TLH relay removes ground from the NS lead used in operating the line hold magnet. This magnet, however, remains locked, and in holding the crosspoint closed maintains the holding path of the marker circuit, HG relay. The HG relay, in remaining operated, indicates proper operation of the hold magnet and closure of the sleeve contact of the crosspoint.

Release of the HG relay, due to a trouble, causes operations given later, it being assumed for this call that it remains operated.

COLD CATHODE GAS TUBE RM 8-11, OS 519

The terminating marker uses a cold cathode gas filled tube for the purpose of checking the closure of the tip and ring contacts of the incoming link and line link crosspoints, and to stick the circuit and provides a trouble indicator record in case of a failure. In a majority of cases the test not only includes the link frame crosspoints but also the subscriber's line cable conductors and the station equipment, so that a trouble in the latter may also be detected by the marker.

The following is a general description of the gas filled type of tube.

If a tube containing an anode and a cathode is evacuated and then a small carefully regulated amount of gas (such as neon, argon or mercury vapor) is put back into, it, the tube is called a gas filled or gas tube. If the cathode is heated indirectly as in most vacuum tubes, the tube is a "hot cathode gas tube;" if the cathode is not heated, the tube is called a "cold cathode gas tube."

If a sufficiently high positive voltage is applied to the anode of a hot cathode gas tube, the electrons boiling out of the cathode are attracted toward the anode. If the attracting positive voltage is high enough, and if there are not too many atoms present, these electrons pick up enough speed so that when they do bump into gas atoms on the way toward the anode, they release other electrons from these atoms. This, in turn, leaves the gas atoms positively charged and they will, therefore, move toward the cathode. Since a large number of electrons are involved, and since all secondary electrons released from the gas atoms will, in turn, release still more electrons on their way toward the anode, the result is that in an extremely short time there is an abundance of electrons and positively charged atoms between the anode and the cathode. As is commonly stated, the gas becomes ionized and becomes a good conductor of electric current, The value of the positive potential which is required to reduce this ionization is called the "ionization," "breakdown" or "striking" voltage of the tube. The potential necessary to maintain the ionization or current flow through the gas is called the "sustaining voltage."

In a cold cathode tube there are, of course, no electrons boiling out of the cathode as a result of heating. Therefore, it might appear that such a tube could not get started even if a high positive potential were applied to its anode. However, there are always a few free electrons and positively charged gas atoms floating in the tube. These start the process which is, of course, cumulative and results in ionization. Once ionized, the gas will serve as a good conductor of electrons or current just as well as in a hot cathode tube with the difference that in the hot cathode tube there is a constant supply of electrons coming out of the cathode, while in the cold cathode tube the supply of electrons results from the positively charged gas atoms striking the negatively charged cathode with sufficient force to release the required electrons.

A third electrode, often called the grid or control anode, is sometimes used to control the instant of ionization. As in a vacuum tube, this grid or control anode is placed in a tube in such a way that it has greater effect on the electrons than the main anode when ionization is getting started. In other words, it is either physically closer to the cathode than the main anode is and can, therefore, start ionization with a smaller positive potential, or it effectively screens the main anode from the cathode, thus preventing the main anode from attracting the electrons even with a positive potential on it. In either case, the grid can be given control of the start of ionization. However, once ionization has occurred, the grid generally loses its control because even though it is made negative with respect to the cathode (in order to try to repel the electrons back toward the main anode and stop the current flow), the abundance of positively charged gas atoms in the vicinity of the grid neutralizes this negative potential of the grid and the current, therefore, continues to flow. It is, however, possible to construct a grid in such a way that it can stop the current flow by making its screening of the main anode very effective. This can be accomplished, for instance, by using a very closely meshed wire gauze grid completely surrounding the cathode and applying a relatively high negative potential to it.

Some of the uses to which a gas tube can be put are readily apparent. The tube is, in effect, an electronic switch which can be closed in an extremely short period of time, and with practically no power, by the mere application of a suitable voltage either to its anode, if it is a two element tube or to its grid if it is a three element tube. Once the tube is ionized, a relatively large current can flow through it. If the effect of an intermittent closing and opening of the switch is desired, the current flow has to be stopped either by opening the circuit or reducing the anode potential of the tube below the value necessary to maintain ionization, or in some cases by grid control. For consistent results on intermittent operation, it is necessary to provide enough time between each ionization period to deionize the gas in the tube completely. This time may be anywhere from a few to a thousand or so microseconds.

Obviously cold cathode tubes require no power except when actually discharging and thus are useful as stand-by devices. The cathode is usually much larger in area than the anode, and as a result, a gas tube will pass current in one direction more readily than in the other.

CROSSPOINT CONTINUITY TEST

The (A) tube is a gas filled tube used by the marker to make the check of continuity of crosspoints. It is a cold cathode, three electrode tubes containing neon and argon gases.

The elements of the tube consist of two anodes, shown as terminals 1 and 2 on the print, and a cathode, shown as terminal 4. With the marker normal and until the NK-1 relay operates a path is closed for partial ionization of the tube, this path being traced from the AC-DC power lead (ringing current) in figure 17-A terminal 3 to terminal 1 of the CON repeat coil, normal contacts of the NK-1 relay, through the CON-2 resistance, and the AN resistance, to terminal 1 of the tube, and from terminal 4 of the tube to ringing ground. This current is partially shunted by ringing ground at the CON-3 resistance, closed through the 8-5 winding of the CON repeat coil and the CON-1 resistance.

The above path provides a low current circuit for ionizing the gas in the tube. This is necessary in order to prevent a change in the potential at which the control gap (terminal 1 to 4) will break down after long periods of idleness.

When the NK-1 relay operates, this path is opened and battery is connected to terminal 1 of the CON repeat coil. This closure completes a path from the AC-DC power lead, through the 3-1 primary winding of the CON coil, to battery. The coil acts as a transformer and steps up the ringing voltage to about 165 volts at the peak of the wave, increasing the current through the control elements of the tube. These elements are connected one on either side of condenser A, one of them being in series with 200,000 ohms resistance. Closure of battery to terminal 1 of the CON coil is delayed until the NK-1 relay operates to reduce the drain on the ringing supply.

When the GLH relay operates, 110 volt positive battery is connected through the windings of the CON and CON-3 relays to the No. 2 terminal (anode) of the tube.

With the tube prepared as above, the crosspoint continuity test is made.

Marker circuit GLH-1 relay operates and locks.

When the GLH relay operated it connected ground to the RT lead to the incoming link and connector circuit to discharge the capacity of the RT and TT leads in preparation for the crosspoint continuity test. The GLH-1 relay is slow operate to allow time for this function to take place before the ground is removed.

Ground through the winding of the FCG relay is disconnected from the TT lead and the LLGE relay will also release.

The slow release feature of the LLGE relay will be required on sleeve guard recycles.

The A cold cathode tube operates.

Operation of the GLH-1 relay connects ground to the TT lead and connects the RT lead to terminal 8 of the CON coil. The TT and RT leads are closed at this time through the incoming link and connector circuit, the incoming trunk circuit and the incoming and line link switches to the called line.

Closure of this path causes a voltage drop across the A condenser. If the voltage drop is caused only by capacity and leak of the switches and associated cabling, it is less than the breakdown voltage of the tube. Operation of the line hold magnet, however, which occurs at about this time, adds the capacity and leak of the line. This causes a sufficient voltage drop across condenser A, as measured by the control elements of the tube, to cause the control gap of the tube to break down and the anode circuit consequently becomes effective.

If the crosspoint contacts and line hold magnet break contacts are adjusted so that the ring crosspoint contact closes before the ring line hold magnet contact opens, the tube may be ionized due to a circuit through the line relay to battery. However, the continuity test will have performed the functions required of it, since it will have checked the path through the crosspoint including the line crosspoints.

If the tube is not operated through the line relay, it operates due to a circuit over the cable conductors and through the station condenser, to ground in the marker on the TT lead, except on a line loop of approximately two miles of cable or more. In this case the capacity of the cable is sufficient to break down the tube and the station condenser is not tested.

The conditions that exist at the time that the continuity test is made.

Using the simplified circuit on OS 519 assume that at a particular instant a current flows from the winding terminal through 200,000 ohm resistance, across the plates of the A condenser and back to the winding terminals. This allows a definite amount of current to flow which in turn causes voltage drops across the 200,000 ohm resistance and the A condenser. The voltage drop across the resistance will be about 5 times greater than the drop across the condenser.

When the GLH-1 relay operates, the continuous circuit through the various closed crosspoints to the subscribers cable and station equipment, provides a path that is in parallel with the 200,000 ohm resistance. This parallel path makes the net resistance of that portion of the circuit considerably lower than the original 200,000 ohms with the result that there will be less voltage drop across this portion of the circuit and a greater one across the A condenser. This increase in the difference of voltage between the plates of the condenser provides a high enough voltage at the control anode to cause the gas to ionize sufficiently to become a conductor. This occurs instantaneously at the time that the potential difference across the plates of the condenser rises above 72 volts which is the breakdown voltage of the control gap.

Failure of the continuity test is not covered at this time, it being assumed for this call that the tube functions. Consequently, in any of the above cases, current flows in the anode (plate) circuit of the tube.

Marker circuit CON and CON-3 relays operate in series disconnecting the RT lead from the CON coil.

Disconnection of the RT lead from the CON coil and the removal of ground from the TT lead do not stop the action in the tube. It continues to function due to the circuit closed by operation of the NK-1 relay, from the AC-DC power lead through the primary winding of the CON coil, to battery. The current induced in the secondary winding of the coil, while not sufficient to break down the control gap of the tube, is sufficient to cause it to continue to function after the tube has operated.

The continuity test circuit is opened at this time in order to prevent bell tapping.

Battery is connected to the RT lead to charge the line capacity, so that the surge, which occurs when relay GT is later connected to the line, will be reduced.

Marker circuit CON-1 and CON-2 relays operate in parallel. OS 519

The lead 0-L to 9-R from the incoming link and connector circuit, used to release the BA relay, is opened.

With this lead opened, the BA relay remains normal as it is connected differentially.

Ground is removed from the PC punching. (CON-1)

Removal of ground from the PC punching at this point permits the marker peg count register to release between calls, if the marker should be seized for another call immediately upon its release.

Ground is connected to the NP lead to the number group connector circuit.

> This lead is closed through the number group connector circuit to the traffic register circuit. It is used with a peg count register for the number group connector circuit. This register has the interval between seizure of the number group and operation of the CON-1 relay to release, if necessary.

The primary winding of the GT relay is connected to the TT lead, and in series with the winding of the PU relay to the RT lead also. OS 520

The GT relay is connected to the line for ground test the PU relay will be used in connection with trouble intercept.

Ground is connected to the No. 1 terminal of "A" tube.

> The ground connected to the No. 1 terminal of the tube is negative in respect to the 110 volt positive battery on the anode. Thus, at this time, the No. 1 terminal is being used as a cathode, rather than an anode in order to sustain conduction. This is necessary to prevent a sputter condition which would increase the variation in breakdown voltage and shorten the life of the tube.

CHECKING THE RINGING CONTROL RELAYS OS 520

The marker circuit includes ringing control relays RC, RV and TC, used to operate corresponding relays in the incoming trunk circuit for setting up the ringing, charge, busy back or overflow conditions required for a call. On a charge call to an idle line, relay RC is used. The functions of the RV and TC relays are given later.

The ringing relays in the trunk circuit, when operated, extend their locking grounds back to the marker to hold corresponding check relays for relay RC-1. On a regular call when one of the check relays RC-1, RV-1 or TC-1 is held operated by ground from the incoming trunk circuit, the correspondingly designated RC, RV or TC relay in the marker should match. These conditions are checked by the provision of operating paths for the GT-1 and GT-2 relays, which are traced through contacts of the ringing control relays operated or normal as required, and also through contacts of the corresponding check relays, operated or normal in the same pattern. The required path is closed when the CON-2 relay operates.

As shown on SC 501 when GT-1 and GT-2 relays operate in parallel, ground is connected to the PC lead to the incoming link and connector circuit.

> This lead is closed through the incoming link and connector circuit to the traffic register circuit. It is used with an incoming peg count register.

The marker circuit SMG relay operates and the line link primary and secondary select magnets release.

> The SMG relay is used to prevent breaking the select magnet circuit at contacts of the line link frame relays, to facilitate contact maintenance.

GROUND TEST AND DOUBLE CONNECTION TEST

The release winding of the GT relay was energized upon operation of the CK-8 relay. When the IK relay operated, it operated the GT relay, this path being closed through the primary winding of the relay and normal contacts of the GT-2 relay.

The operation of the CON-2 relay, connects the primary winding of the GT relay in parallel to the TT and RT leads. The PU relay is in series with the GT relay on the RT lead. The operation of the GT-2 relay opens the operating path of the GT relay, leaving its primary winding connected to the tip and ring leads of the line.

The GT relay is connected differentially and its windings are so proportioned that it releases if there is no false ground on the line in excess of the allowable leak, as in this case the effect of the release winding is greater than that of the operate winding. If there is a false ground on the line, the GT relay remains operated, as in this case the effect of the operate winding is the greater.

This test is made to detect double connections, which would cause the ground from the winding of the incoming trunk S relay, associated with the other call involved in the double connections, to hold the GT relay of the terminating marker on the call being established.

To detect two-party lines which have become grounded and might give a false party line indication, which would result in charging the tip party for a ring party originating call.

To detect crosses between the tip and the message register leads.

To avoid connecting to PBX lines which are off-normal and which would produce false charges.

If the GT relay remains operated, the marker times out, a trouble indicator record is taken and then the call will be set up regardless of the condition of the line.

It is assumed for this call that no false ground is encountered on the line.

Marker circuit GT relay releases.

LOCKING IN CHANNEL

Release of the GT relay removes ground from the FC lead to the terminating marker connector circuit. This lead is closed through the sender and through the crosspoints of the sender link used for the call to the incoming trunk circuit, and was previously used to operate the trunk circuit F relay. Removal of ground from the lead releases the trunk circuit F relay, which in turn connects ground to the S lead between the trunk circuit and the incoming link and connector circuit, and removes ground from the M and LC leads used for the call. It also opens the RC lead and disconnects the S lead from the SL lead.

The operated incoming link and line link primary and secondary hold magnets lock to ground on the S lead furnished by the incoming circuit.

> The completed connection is placed under control of the trunk circuit so that release of the latter after the conversation has taken place will release the incoming link and the line link.

The operated incoming link primary select magnet releases, due to removal of ground from the corresponding M lead by the trunk circuit. (For 100 or 160 trunk incoming link)

The operated incoming select magnet 0 or 1 releases, due to removal of ground from the M-1 lead. (160 trunk incoming link only)

The operated LC relay in the incoming link and connector circuit releases, due to removal of ground from the corresponding LC lead by the trunk circuit.

> Release of the LC relay removes ground from leads AK and FS and opens leads 0-L to 9-R between the incoming links and the marker.

Marker circuit TK relay releases, due to removal of ground from the AK lead.

Marker circuit TKT relay releases, due to being connected differentially.

Marker circuit RC-1 relay releases, due to removal of ground from the RC lead by the trunk circuit.

Marker circuit SL relay releases, due to removal of ground from the SL lead by the trunk circuit.

Marker circuit FS relay releases, due to removal of ground from the FS lead.

The operated AB relays corresponding to busy incoming links release, due to opening of leads 0-L to 9-R.

Marker circuit SL-1 relay releases and the TLH relay operates. The TLH relay in operating will connect ground to the RL lead to the terminating marker connector circuit.

The ground connected to the RL lead is furnished at the sleeve of the incoming trunk circuit and is closed through the sleeves of the incoming link, the line junctor and the line link, over the line S lead to the number group connector circuit and the required NS lead to the marker. In the marker this ground is connected through contacts of several relays to the RL lead. OS 521

RELEASE OF MARKER AND ASSOCIATED CIRCUITS

Ground connected to the RL lead causes the sender to release the connector circuit. The connector circuit, in turn, causes the marker to restore to normal by opening the receiving leads, removing ground from the CKG lead, closing ground to the DA and F leads, and removing ground from the TM and DB leads.

The connector circuit, by opening the receiving leads and removing ground from the CKG lead, releases the marker relays used for receiving the information from the sender. Closure of ground to the DA and F leads causes the marker circuit DA-1 and DA-2 relays, respectively, to operate. These relays in operating remove ground at their contacts from the marker TM lead. This lead, however, is still connected to ground at other points.

When the DB lead is opened by the connector circuit, ground is removed from the DB interrupter and the marker circuit CBR and CBS relays release. Release of these relays removes ground from the associated CB leads to all the connectors, making the marker available for reselection.

The marker may be reselected before all of its operated relays have released, even though the connector does not open the DB lead until after it has opened the receiving leads and the CKG lead. No interference is caused by this condition, however, as all of the relays required for receiving the information from the sender release before the marker can be reselected, and any other relays that may still be operated at this point have ample time to release before they are required for the second call.

The marker and its associated circuits will restore to normal as shown on SC 501.

Following are some notes pertaining to miscellaneous release features.

The recording leads are opened by the connector circuit rather than by the sender in order to prevent the breaking of current at the sender register crosspoints.

The XS-1 and XS-2 relays are slow release, their combined release time being approximately one-half second. They are used to measure the interval between release of the marker and its reseizure. If the XS-2 relay releases before the marker is again seized, the second call proceeds on a "light traffic" basis. If, however, the XS-2 relay is still operated upon reseizure of the marker, the second call is handled on a "heavy traffic" basis in which certain tests are cancelled.

The ALW and ALZ relays are used in connection with "allotted" P.B.X. groups. Both of these relays are left operated at the end of one call and left normal at the end of the next call. If the ALW relay was operated at the beginning of the call, the ALZ relay operates as above at this time. If the ALW relay was short-circuited and released at the beginning of the call, the ALZ relay releases at this time.

The SMG relay is slow release to allow time for the line link frame relays to release before reclosing the select magnet circuit.

The release of the GLH relay opens the path from the positive 110 volt coin control battery to the No. 2 element of the tube causing the tube to de-ionize and lose its ability, to conduct.

INDIVIDUAL LINE BUSY

If the called line is an individual line and is busy, the marker sets the incoming trunk to return the busy signal, releases the sender which in turn releases the connector, and restores to normal without making channel test or operating any hold magnets. In a call of this type, the line choice connector circuit and the line link frames are not called in.

It is assumed in this case that the call has progressed up to operation of the TLT relay, except that, due to the called line being busy, the corresponding S relay in the marker operated upon operation of the twenty block relay. The operating path for an S relay is given in step three. With the S relay operated, the path to operate the corresponding L relay is opened.

Marker circuit BB and BBA relays operate in parallel.

> BB relay locks and BBA holds in parallel.
>
> The BB relay is slightly slow operate to prevent a false busy back signal on a terminal hunting line, if the associated HT relay should prove slower in operating than the interval allowed by the TLT relay. Terminal hunting, including the functions of the HT relays.
>
> The BBA relay has no functions in this case. It is used in conjunction with the subscriber's line overflow register circuit.

Marker circuit OFB relay operates.

Incoming link primary select magnets operates. (160 incoming trunk link only).

Marker circuit FB relay operates.

Marker circuit YBA relay operates.

Marker circuit YB relay operates.

Battery is removed from the ST lead to the number group connector circuit.

Number group connector circuit MP relay releases.

Number group connector circuit MCA relay releases.

Number group connector circuit HB and TB relays release.

Number group connector circuit MCB, MCC and MCD relays release.

> The number group is released at this time to increase its capacity for handling calls during periods of heavy traffic involving the particular number group.

Marker circuit S relay releases.

Marker circuit TC relay operates.

Marker circuit TC-1 relay operates and ground is connected to TC lead to the incoming link and connector circuit in parallel.

Marker circuit RV relay operates.

Marker circuit RV-1 relay operates, and ground is connected to the RV lead to the incoming link and connector circuit, in parallel.

> The TC and RV leads are closed through the incoming link and connector circuit to the incoming trunk circuit. Ground connected to them operates relays which set the trunk circuit to return the busy signal to the calling subscriber. The trunk circuit relays lock and extend their locking grounds back to the marker.

Marker circuit OR relay releases.

> Release of the OR relay opens the operating paths of the TC-1 and RV-1 relays. These relays, however, remain operated from grounds from the trunk circuit on the TC and RV leads, respectively, thereby indicating proper operation of the trunk circuit relays.
>
> The OR relay is slow release to allow sufficient time for the operation of the trunk circuit relays.

Marker circuit SRL relay operates and locks.

The RV-1 relay locks.

Marker circuit CON-1 and CON-2 relays operate in parallel.

Marker circuit GT-1 and GT-2 relays operate in parallel.

The operating path of the GT-1 and GT-2 relays is traced in this case from battery through their windings, in parallel, normal contacts of the X relay, operated contacts of the TC-1, OFB, TC, RV-1 and RV relays, normal contacts of the RC-1 relay operated BB relays, normal contacts of the RC relay, operated contacts of the CON-2 relay to ground.

The GT-2 relay locks and the GT-1 holds in parallel.

Ground is connected to the RL lead to the terminating marker connector.

Connection of ground to the RL lead causes the sender to release the connector circuit.

Marker circuit GT relay releases.

Ground is removed from the FC lead to the terminating marker connector circuit.

Removal of ground from the FC lead advances the incoming trunk circuit as described for a regular call. This causes the following:

Marker circuit TC-1 relay releases.

Due to removal of ground from the TC lead by the trunk circuit.

The RV-1 relay does not release, even though the trunk circuit opens the RV lead, as a locking path was provided for it when the SRL relay operated. This is done to prevent a short closure on the RL lead, as otherwise the release of the RV-1 relay would interrupt the release ground and also cause the OR relay to reoperate.

Release of the connector circuit causes the marker and the incoming link and connector circuit to restore to normal. The operated relays in these circuits release as in a regular call. The BB, BBA, and YB relays release when the CK-6 and CK-7 relays release. The OFB and TC relays release when the BB relay releases. The RV relay releases when the BB relay or YB relay releases. The SRL relay releases when the IK relay releases and in turn releases the RV-1 relay.

CHAPTER 8

SECTION 3

MISCELLANEOUS INFORMATION AND FEATURES

Terminating Marker Circuit	SD-25283-01
Number Group Connector Circuit	SD-25276-01
Incoming Link and Connector Circuit 160 Trunk Capacity	SD-25457-01
Incoming Link and Connector Circuit 100 Trunk Capacity	SD-25032-01
Line Choice Connector Circuit	SD-25275-01

MARCH 1954

MULTI-OFFICE OPERATION AND PHYSICAL AND THEORETICAL OFFICES
RM 516-519

As stated before the minimum number of terminating markers furnished in an office is three, although one or two might be enough to carry the load in a light traffic area. Where two such offices are located in the same building, this means that six markers would be furnished, although three or four could handle the load provided the markers could be used in common. Further economies and advantages would result if other terminating frames could be used in common, due to the increased efficiency of larger groups.

Accordingly, provisions have been made on the various circuits so that the terminating marker, terminating marker connector and terminating sender link frame and the four types of terminating senders may be used in common by two 10,000 office units. The line link, incoming link, and incoming trunk frames can be used in common without any special arrangement in their circuits. The incoming trunks themselves may be in either a common or individual group. The number group connector and block relay frames must remain individual to each 10,000 office unit. A line distributing frame is provided which makes it possible to cross-connect the sleeve of any line to any number in either office unit. This LDF will consist of two of the single unit frames placed back to back about 6" apart with cover plates to fill in the space between guard rails and with details to mount to fanning rings required for the jumper wires between opposite sides of the distributing frame.

When the terminating marker is arranged for multi-office operation it is capable of completing calls to 20,000 numbers, the capacity of the marker regarding the number of incoming trunk frames, line choices, split hundreds relays, allotment of P.B.X.'s and extra numbers are the same as the limits established for single office operation. The three later features can be apportioned to the two offices as required.

With regards to the number groups, the arrangement provides for only ten or twelve number groups per each office with multi-office operation which is a reduction from the limit of twenty-five permissible for single office operation. To increase this limit of the number groups and maintain an orderly terminal, cabling and cross-connection arrangement for the marker cross-connection field, it would be necessary to increase the size of the marker frame. This would be undesirable, since the types of offices to which multi-office operation will have application, will not exceed twelve number groups per office. If the case arises where the number of number groups required for one office will exceed twelve but the total for the two offices will not exceed twenty-four, such a case will require minor rearrangement in cabling and stamping at the marker frame and will be handled on a job basis.

The principle functions of multi-office operation are the transmittal of an office signal to the marker via the terminating senders and translation of this signal by the marker for the selection of the proper 10,000 numbers. To accomplish this, another set of 20-five-hundreds relays (FH) and associated ST and

HB punchings are provided in the marker. This second set of (FH) relays are associated with the 10,000 numbers of office "B" as shown in HM 515. The 0-9' leads from the marker register relays are not made common to two multi-contact relays (OA) and (OB) through whose contacts the register leads are extended to the proper set of five-hundreds relays. The (OA) and (OB) relays will be operated under control of the (OAB) relay. The (OAB) relay will be normal or operated depending on the office in which the called number is located.

Two offices in the same building, not in excess of 10,000 numbers each, may be arranged to utilize common terminating equipment if each of them has a low or moderate calling rate. This is accomplished by one of two general plans.

PLAN NO. 1	PLAN NO. 2
Equipment common to two office units	
Terminating Markers	Terminating Markers
Terminating Marker Connectors	Terminating Marker Connectors
Terminating Senders	Terminating Senders
Line Link Frames	
Incoming Trunks (with individual & common trunk groups)	
Line Choice Connectors	
Line Junctor Connectors	
Equipment individual to each of the two office units	
Number Group connectors	Line Link Frames
Block Relay Frames	Incoming Trunks (with individual trunk groups only)
	Line Choice Connectors
	Line Junctor Connectors
	Number Group Connectors
	Block Relay Frames

PLAN NO. 1

Where incoming and line link frames common to two offices are provided, there may be as many as twenty incoming frames and line choices. With the line link frames of two offices consolidated in this manner, the numbers of the two different central offices may be assigned to the same party line circuits, permitting greater party line fill. The use of common incoming frames makes it possible to have individual trunk groups from some of the offices in the local dialing area and common trunk groups from others, to the two crossbar offices arranged for multi-office operation.

The office signaling arrangement is dependent upon two conditions.

1. The arrangement of the trunk groups, whether they are individual to each office or common to the two offices.

2. The type of incoming call involved, whether it is full selector, "B" switchboard, AC Key pulsing or dial pulsing.

For individual trunk groups the (trunk group) relays (TG) in the terminating sender link and control circuit associated with the trunks of office "A" are cross-connected within the sender link to the "OA" lead to operate an (OA) relay in the sender. Likewise for individual trunk groups associated with trunks of office "B" the (TG) relays are cross-connected to the (OB) leads to operate on (OB) relay in the sender. With the (OA) sender relay operated no signal is transmitted to the marker over the "OAB" lead but a check circuit is closed to insure the non-operated condition of the (OB) sender relay and (OAB) marker relay, which is an indication that the called number is in office "A". With the (OB) sender relay operated the "OAB" lead is grounded which operates the (OAB) relay in the marker which indicates that the called number is in office "B". From thereon the (OAB) relay controls the selection of the proper 10,000 numbers.

OFFICE INDICATION FOR FULL SELECTOR CALLS

For the trunk groups which are common, a signal is required from the originating sender as well as from the terminating sender link and controller circuit, in order to identify the office called. The signal from the terminating sender link is used as the office "A" signal, while this signal in combination with the signal from the originating sender determines the selection of office "B". The arrangement for the originating sender is to transmit the signal on a revertive pulse basis when incoming selection is made and is accomplished by using the normal number of pulses (0-3) for office "A" and adding five pulses to the normal selection for office "B". In the terminating full selector sender, the incoming group (IG) vertical unit on the register switch is wired so that one contact of the crosspoint controlled by select magnets 5 to 8 functions as the control of the office "B" signal. The crosspoint controlled by select magnets 0 to 3 have no effect on the control of the office "A" signal; this signal being a function of the terminating sender link. However the 0-3 crosspoint connection closes through the check circuit to the sender (OA) relay to insure the non-operated condition of the OAB relay in the marker which is required when transmitting an office "A" signal, as shown.

OFFICE INDICATION FOR CALLS FROM "B" SWITCHBOARD

The arrangement for the "B" switchboard equipment provides for incoming trunks in groups individual to each office, common to both offices, or a combination of individual as well as common groups, for the return of the proper order tone and for the grouping of calls on an office basis when the "B" switchboard handles both panel and crossbar office calls.

With the trunk in groups individual to each of the two offices, the appearance of the trunks in the terminating sender link and controller circuit and the transmittal of the office signal is in accordance with the arrangement previously outlined.

With common trunk groups, the situation is comparable to common full selector trunks in that the office signal must be obtained from sources other than the terminating sender link. Accordingly, for common trunk groups, the "B" position requires an office key for each of the two offices, which when depressed, transmits the office signal to the "B" sender to operate equipment to give an above 5 or under 5 indication. Calls requiring an office key with the numerical keys are considered as "five key calls" and on such calls the equipment is arranged to send the single order tone to the manual originating operator, thereby indicating that the office name must be given. This is done by cross-connecting the (TG) relay associated with the trunks that are common to both offices to the "OC" lead which operates the (OC) sender relay. The operation of the (OC) relay gives a signal (reverse battery) that controls the sending of the single order tone and the lighting of the office lamp at the originating operator position, indicating to the operator that the office name along with the directory number is to be transmitted to the "B" operator.

When the trunks are in common groups as well as individual groups, the equipment arrangements provide for operation on a four-key basis for the individual groups and on a five-key basis for the common groups, or when uniformity in operation is desired, to operate on a five-key basis for all calls.

OFFICE INDICATION FOR CALLS FROM SWITCHBOARDS EQUIPPED WITH DIALS

When calls are completed by direct dialing over incoming trunk circuits, "dial pulse" terminating senders are required.

The arrangement of the sender as regards the signal is comparable to the "B" switchboard arrangements in that for trunk groups individual to each office the signal is a function of the terminating sender link and controller, and, therefore, the call can be completed by dialing four digits only, while for common trunk groups the selection of the proper 10,000 number is obtained by dialing an office prefix digit followed by the four digits of the number. Accordingly, the sender provides for both four digit and five digit dialing with the information of whether four or five digits are to be received; being controlled by the terminating sender link.

An office digit is required for each of the two offices and flexibility is provided so that they can be selected as desired.

To aid the operator as to whether four or five digit dialing is required, the sender is arranged to send the regular dial tone (low tone) on four digit calls and a high tone on five digit calls.

The (OA), (OB) and (OC) relays are provided in the sender and are used in a similar manner to the arrangement in the "B" switchboard sender, except in the case of the dial pulse sender the (OC) relay controls the sending of the low and high tones, for common incoming trunk groups.

PLAN NO. 2

When incoming link and line link frames individual to each office are provided the number of incoming frames and line choices for each office can not exceed ten. This limitation being established due to the limitations of the markers to function with a maximum of 20 incoming frames and line choices. Ten incoming frames and line choices serving office "A" and the same number serving office "B". The marker must select between line choices 0-9 for office "A" and 0-9 for office "B". This is accomplished by assigning the marker line choice selection relays 0-9 so serve office "A" and 10-19 to serve office "B".

This plan precludes the use of trunk groups common to the two offices, and does not permit the assignment of numbers with different office prefixes to the same party line.

The "F00" and "F10" leads are used for sending the office signal and their function is as follows:

The terminating sender link frames of office "A", must have frame numbers below ten (0-9) which send a signal on a frame basis over the "F00" lead, while sender link frames of office "B" will have frame numbers above ten (10-19) and the signal is sent on a frame basis over the "F10" lead. The low 10 frame indication is accepted in the marker as being a call for the office "A" numbers and the high 10 frame indication as being for office "B" numbers. The use of the "F00" and "F10" leads for this purpose is in addition to their primary function which is to give frame indications to the marker. A signal over one or the other of these leads will operate either (F00) or F10) relays in the sender and they in turn control the operation of the (OAB) relay in the marker. From thereon the selection of the proper office is handled.

PHYSICAL AND THEORETICAL OFFICE

In a central office installation, the area served by the central office may be in two different rate zone making it necessary to segregate the incoming traffic in accordance with the established rates. In such cases, where the installation does not exceed 10,000 numbers this segregation may be obtained by establishing a "physical" and "theoretical" office, with the number series of the physical office being distinct from that of the theoretical office.

For example:- If we divided a 10,000 number series into two groups, say numbers 0000 to 5999 are assigned to (A) office which will be the physical office and that numbers 6000 to 8999 are to serve the (B) subscriber in the theoretical office, we now have two separate office codes that must be used to reach one or the other groups of subscribers in the same 10,000 number series.

At some later date if the number of (B) subscribers increases and a single office unit no longer provides sufficient equipment to take care of the subscribers of both offices, the multi-office plan may be used, in which case Pacific subscribers will be served by a physical second office unit.

In order that the completion of subscriber calls to the physical and theoretical offices can be controlled in accordance with the rates established for the originating offices, the arrangements provide for office discrimination or non-discrimination on calls as desired. When there is an extra charge on subscriber calls to the theoretical office, guards must be provided to block subscriber attempts to defeat the rate differential by dialing (or passing to an operator) a combination of the physical office name and theoretical office number. Accordingly, the "office discrimination" feature is provided whereby the physical office name and numbers and the theoretical office name and numbers must be in proper combinations, otherwise the call will be routed to an intercepting operator. However, there may be cases when it is desirable to permit completion of the call to all numbers regardless of the office prefix used. Such calls are considered as being on a "non-discriminating" basis and the terminating arrangements provide for this feature. Illustrations of the application of the non-discriminating feature are on connections on which there is no differential in rates on calls to the physical and theoretical offices such as calls from subscribers in the same or adjacent exchange areas and connections from the toll switchboard.

On the other hand, there are conditions where it is desirable for arrange a group of numbers on a non-restricted basis. For example:- The official 9000 numbers would make up such a group where it is necessary to give incoming calls access to these numbers regardless of their restrictions to numbers in the physical or theoretical offices.

Discrimination and non-discrimination is obtained by transmitting signals to the marker from three sources as follows:

1. From the incoming link frame via the incoming link connector.
2. From the block relay frame via the number group connector.
3. From the terminating senders. While the signal from this soruce has the primary function of selecting the proper 10,000 numbers of a 20,000 number multi-office terminating unit installation, in some instances it is used in conjunction with the signals from sources 1 and 2 above to obtain discrimination between the physical and theoretical office.

A multi-office terminating unit of 20,000 numbers may have physical and theoretical office operation in either or both of its offices "A" and "B".

The manner in which the terminating marker matches two signals that it receives to check the correctness of the combination of office code and directory number dialed is illustrated in figure 12B and explained as follows:-

Leads "X" and "Y" from the ringing control circuit are run through the contacts of marker relays (IP), (IT), (IPT), (PN), (TN), (PTN) and (TC) and through the operation of these relays, either individually for some or in combinations of two for others, the closure of lead "X" to "Y" is made possible. On each call lead "X" must close to lead "Y" or the call will be blocked by the marker.

The relays designated (IP), (IT), and (IPT) represent (incoming physical discriminating) (incoming theoretical discriminating) and (incoming physical or theoretical non-discriminating) respectively and will operate on an incoming signal. The windings of each of these relays are wired to correspondingly designated punchings in the incoming link frame where they may be cross-connected to PT2 - PT9 punchings that are wired to off-normal contacts of select magnets on an incoming link primary switch. For each group of trunks that are discriminating to either the physical or theoretical office, cross-connections are made between the PT-2 - PT-9 punchings, associated with that group of trunks, and the (IP) punching if restricted to the physical office or (IT) punching if restricted to the theoretical office. For a group of non-discriminating trunks the cross-connections would be between TP2 - TP9 punchings and the (IPT) punching. When an incoming trunk is closed through to the incoming link the operation of the select magnet on the primary switch closes battery through its off-normal contacts, through the cross-connection to operate an (IP), (IT) or (IPT) relay which serves as an indication to the marker that the trunk is restricted or non-restricted to either the physical or theoretical office.

The relay designated (PN), (TN) and (PTN) represents (physical office numbers), (theoretical office numbers) and (non-restricted numbers) respectively and will operate on a number group signal. The windings of each of these relays are wired to correspondingly designated punchings on the block relay frame where they may be cross-connected to PT punchings that are wired to contacts of (HB) relays. For each group of 100 numbers that is assigned to either the physical or theoretical office, cross-connections are made between the PT punching, associated with that (HB) relay serving the 100 numbers, and PN punching if assigned as physical office numbers or PT punching if assigned as theoretical office numbers. For each 100 numbers in the common group the PT punching will be cross-connected to the PTN punching. When the (HB) relay on the block relay frame operates ground is closed through its contacts, through the cross-connection to operate a (PN), (TN) or (PTN) relay which serves as an indication to the marker that the group of 100 numbers is assigned as either physical or theoretical office numbers or is a common group that may be reached without restriction by all incoming calls.

With the proper combinations of the relays operated in the marker such as (IP) and (PN) or (IT) and (TN) the ringing control circuits leads "X" and "Y" will be closed through permitting the call to be completed.

In the event a subscriber who is restricted to making calls to the physical office only, should dial the physical office code and theoretical office number the (IP) and (TN) relays would operate. This is a wrong combination which leave leads "X" and "Y" open and cause the marker to route the call to the intercepting operator. This same condition results if the (IT) and (PN) relays operate.

With either the (IPT) or (PTN) relays individually in the marker the ringing control circuit leads "X" and "Y" are closed permitting the marker to complete the call. The (IPT) relay operated is an indication to the marker that the call is coming by way of a group of trunks common to both the physical and theoretical offices and is not restricted regardless of which number group relay (PN) or (TN) is operated. The (PTN) relay operated is an indication to the marker that the call is to a group of numbers that is not assigned to either the physical or theoretical office, but is common and regardless of which incoming group relay (IP) or (IT) is operated, the call may be completed. This is also true for such connections as busy back, overflow and calls to free lines, in which case the operation of (TC) relay alone will close the "X" and "Y" leads causing the marker to proceed.

CHAPTER 8

SECTION 4

MISCELLANEOUS INFORMATION AND FEATURES

Terminating Marker Circuit	SD-25283-01
Number Group Connector Circuit	SD-25276-01
Incoming Link and Connector Circuit 160 Trunk Capacity	SD-25457-01
Incoming Link and Connector Circuit 100 Trunk Capacity	SD-25032-01
Line Choice Connector Circuit	SD-25275-01

MARCH 1954

PARTY LINES - OS 511

The NF cross-connection on the block relay frame for any directory number may be cross-connected to one of three fields, RF, HF, or TF. The RF field is used for individual or ring party lines, the HF for first and intermediate PBX lines and the TF for tip party lines.

On two party service each party has its own directory number for the purpose of indicating the proper type of ringing control in the incoming trunk. Outside of this fact, the NF and NC cross-connections are connected for the same information.

During marker operation for a tip party number, after line test, the L relay causes the LC and the TF relay to operate. The RV relay is then operated through the make contacts of the TF relay, in turn operating the RC relay. This causes relays RV and RC to be set in the incoming trunk for tip party ringing.

The operation for a ring party number is the same as an individual line, as described for a regular call.

SECOND TRIAL

If the marker fails for any reason to function properly on a first trial, its time measure circuit times-out and calls in the trouble indicator. After the trouble indicator has taken a record of the trouble or if the trouble indicator is busy, ground from the TM7 relay is connected to the TRL lead instead of the RL lead toward the marker connector circuit. The connector releases the marker and selects another marker, usually one other than the one involved on the first failure, for a second trial.

When a connector circuit seizes a marker for a second trial, it connects ground to the TR2 lead.

Marker circuit TR2 and TR3 relays operate in parallel.

> The operating circuit of the XR relay is opened. The contacts of the RC and RC1 relays, used to operate the GT1 and GT2 relays, are short-circuited.

The above function allows calls to be set up even if the RC lead is open or grounded to the incoming trunk.

The channel preference circuit is advanced five steps.

> The purpose of this is to permit a new channel to be selected rather than risk the possibility of selecting the same channel, in the event that the previously selected channel (1st trial) caused the failure.

When the TLH relay releases, the CON1 and CON2 relays operate, if line continuity test fails.

The ground test and continuity test are cancelled on second trial to permit test incoming trunks to complete to lines in trouble and salvage calls over which conversation can be held in spite of trouble.

The ground for operating the line hold magnet is closed through the TR3 relay.

This pair of contacts bridges the normal contacts of the X relay through which the above circuit is usually connected. This is done in order to save time in the event that the X relay is only momentarily operated. On first trial calls the circuit will not proceed to operate the line hold magnet unless the X relay is normal, but will permit its operation on second trial calls.

The operating path of the XS relay is opened.

This has the effect of cancelling the test for grounded or crossed NS leads and the test for grounded NF leads if it is being made. In this case calls can be set up to lines other than the one whose leads are falsely grounded.

Marker circuit TR1 relay operates causing the MPS, MK0, MK1 and RSM leads to the incoming link and connector to be opened, the EPS, MK2 and MK3 leads to be closed and the TR lead to be grounded.

This prepares the marker for use with the emergency mate frame lock out circuit of the incoming link and connector circuit.

Incoming link and connector circuit TR relay operates.

The TR relay operates, after the incoming link and connector circuit is seized, from ground connected to the TR lead by the TR1 relay of the marker. The operation of the TR relay causes the emergency mate frame lock-out circuit to be used in the same manner as described for the regular mate-frame lock-out circuit.

If for any reason the marker encounters trouble on a second trial, ground is connected to the TRL lead, thereby affecting the release of the terminating or "B" sender provided a plug is not inserted in the hold jack associated with the sender. If a plug is in the hold jack, the sender involved does not release. However, in either case the connector and marker circuits are dismissed.

CCT JACK - OS 520

The CCT jacks 0 to 9 on the trouble indicator frame, in combination with the NPC, CCN or PBX jack, are used to cancel line continuity test and ground test, for one or all markers. Failure of the CON relay to operate in most cases is probably due to outside plant equipment trouble. These jacks are provided to prevent a large number of trouble indicator records, in such cases.

The CCT jacks 0 to 9 make it possible to treat markers individually in cancelling the test but are ineffective if not used with the NPC, CCN or PBX jack. The purpose of these jacks are as follows:

Cancel On	Use Jack	For Any or All Marker
Non-P.B.X. and Non-Coin Lines	NPC	CCT
Coin Lines	CCN	CCT
P.B.X. Lines	PBX	CCT

With a plug in the CCT and NPC jacks the marker CCT relay operates and one path to ground the FC lead is opened.

> The regular path for keeping the FC lead grounded after the GLH-1 relay has operated is opened. When the marker is seized for a call it proceeds as described for a regular call. In addition, however, the operation of the marker CK-6 relay causes the marker PU-2 relay to operate and the path for grounding the FC lead is closed through the GT relay.
>
> From this point the marker proceeds as described for a regular call, the operation of the GT relay with the IK-1 relay operated resulting in the grounding of the FC lead. When the TLH relay releases with the CON relay normal the CON-1 and CON-2 relays operate through a make contact of the CCT relay, thereby cancelling line continuity test.

After the check of the ringing control relays the operation of the GT-1 and GT-2 relays on a satisfactory check connects the GT relay across the line and causes the PU-2 relay to release.

> The PU-2 relay is slow release to allow sufficient time for the GT relay to release or a plugging up cord indication to be effective.

If due to a false ground the GT relay should fail to release then ground is removed from the FC lead to the terminating marker connector circuit.

> The removal of this ground releases the incoming trunk F relay and the marker proceeds from this point as described for a regular call. The CCT relay does not release until such time as the plug is removed from the CCT and NPC jacks at the trouble indicator frame.

TERMINAL HUNTING LINES

GT TEST

GT LOOP TEST - FIRST TRIAL - OS 519

When the terminating marker circuit operates the number group TB relay and with the LE3 to LE6 relays operated, the NF cross-connection for those lines that are assigned to PBX groups, not the last line, cause the associated HTO to HT19 relays to operate. When line test is completed the marker L relay in operating causes the associated HT relay to release. All other operated HT relays release when the LE3 to LE6 relays release.

The selected L relay then causes the marker LC relay to operate which together with the released LE3 to LE6 relays causes the HF relay to operate on first or intermediate PBX lines or the RF relay on last lines of a PBX group.

With the HF relay up the marker circuit HF-1, CN and CNL relays operate.

> When the SL1 relay operates, during the check of the selected channel, it connects a locking circuit to the HF1 relay.
>
> The terminating marker is arranged to make the GT test on a loop basis for terminal hunting lines which use the HF cross-connection field. This test takes place upon the operation of the GT2 relay at which time there is a loop circuit for the GT relay to the TT and RT leads, to the station equipment.
>
> With the CN relay operated, operation of the GT-2 relay opens the parallel path of the GT relay from the RT lead. The circuit for holding the GT relay operated after the ground test and providing there is a PBX-ROH, is as follows: battery winding of GT relay, make contacts CON-2 relay, parallel circuit of break contacts and make contacts of TR2 and CN relays respectively, make contacts GLH1 relay, back contacts MT-4 relay, to TT lead, channel tip crosspoints to station equipment ROH back on channel ring crosspoints to RT lead, back contacts MT-4 relay, make contacts GLH and GLH-1 relays, parallel circuit of break contacts of TR2 and CN relays respectively, winding of PU relay, make contacts CON-2, CN and IK relays to ground.
>
> The PU relay on the ring side of the loop test will not operate unless a low resistance of 48 volt battery circuit is encountered.

The GT-1 relay operates at the same time as the GT-2 relay and causes the CNL relay to release.

> The CNL relay is slow in releasing to allow time for the GT relay to release, which in turn causes the SL and SL-1 relays to release.

If the GT relay remains operated after the release of the CNL relay the marker circuit HF-4 relay operates and locks and closes a holding path for the GT and HG relays.

> The GT relay is held operated to prevent the early release of the incoming trunk F relay which otherwise would lock-in the channel hold magnets and allow connection to the PBX line, following the trouble release later.
>
> The HG relay is held operated to prevent reroute to open sleeve intercept.

Incoming link and line link primary and secondary hold magnets release.

The release of these hold magnets at this time insures their being normal before the F relay of the trunk is released between trials.

Marker circuit DL and TR relays operate and battery is connected to the TIS lead to the terminating trouble indicator.

The TR relay operated calls in the terminating trouble indicator to record the GT failure, on first trial calls. During the release of the marker the HF4 relay releases upon the release of the NK-1 relay.

The terminating trouble indicator grounds the TIB lead to the marker causing the TTIB relay to operate and lock.

Operation of the TTIB relay connects ground to the terminating marker connector TRL lead. That circuit advances, releases this marker and then reconnects to a marker for a second trial.

GT LOOP TEST FAILURE - SECOND TRIAL - OS 519

On second trial calls when a terminal hunting line is selected, due to the TR2 relay being operated, the CN relay closes the circuit for the GT loop test.

If the GT relay remains operated after the release of the CNL relay on second trial calls with the TR2 relay operated or on first trial calls with the CCT relay operated the HF-2 relay operates and locks and the HTR relay releases, if operated.

This is to avoid premature reoperation of the GLH relay.

The GLH and GLH1 relays release connecting a holding circuit to the incoming trunk F relay.

The LLGE and HF-5 relays operate and the TKT and selected CH relays release.

The operated primary and secondary hold magnets for the incoming link and line link release.

The SL, SL1 and HF-1 relays release and the HF-3 and an LB- relays operate.

There are four LB relays in the marker designated 0 to 3, used to provide a busy indication on a scattered group of four S relays.

The LB relay to operate is determined by the L relay operated, relay LB-0 being used with L relays Nos. 0, 4, 8, 12 and 16; relay LB-1 being used with L relays Nos. 1, 5, 9, 13 and 17, etc.

The LBK, LBK-1, SG, SGA and INA relays operate and the L relay for the line first selected releases.

The release of the L relay causes ground to be removed from the NF and NC leads (cross-connections) corresponding to the line first selected, thereby resetting the marker to the stage preceding line test. This causes the operated CA or CB, LLG and LC relays to release. The operation of the SG relay causes the line choice circuit to release and the release of the LLG relay causes the LLGE relay to release. The slow release LLGE relay prevents the operation of new CA or CB and LC relays before the first ones have released.

Marker circuit S relay for line first selected operates and the SG and SGA relays release.

The release of the SGA causes the LE1, LE2 and LE12 relays to operate and the INA relay to start releasing. The LE12 reoperates the LE3 to LE6 and LE8 to LE11. This operates the LE7 relay which connects a holding circuit for the INA, thereby preventing its full release. Also operated at this point is the LE relay. The release of line choice connector causes the release of the marker LK relay which releases the HF5 relay.

With the LE relay operated and the LK and LLGE relays released, the short-circuits on the P- condenser are removed allowing the TLT relay to condenser time for a recycle of line test, thus choosing a PBX terminal other than the one first selected. From this point the marker continues as in a regular call.

GT LOOP TEST FAILURE FOLLOWING PBX RETEST ON SECOND TRIAL
OVERFLOW TONE - OS 519

Should the GT relay fail to release following the retest, then when the CNL relay has released the CNL-1 relay operates and locks.

Ground is removed from the LL lead to the line choice connector circuit.

This causes the incoming link and line link primary and secondary hold magnets to release.

Marker circuit CNL2, OF, OFB, TC, TC1 and incoming trunk TC relays to operate.

The YBA relay operates and the L relay releases.

This causes the CA or CB, LLG and LC relays to release. Release of LC relay opens ST lead to line choice connector causing that circuit to release.

The YB relay operates causing a hold circuit to be connected to the NK relay and opening the ST lead to the number group connector releasing that circuit.

The RV, RC, RV1 relays in the marker and the incoming trunk RV relay operate.

The RC and DR relays in the marker release.

> The OR relay is slow in releasing to allow sufficient time for the marker TC, RV and RC relays to operate, in turn operating the same group in the incoming trunk, for overflow, before connecting the regular release.

Marker circuit SRL relay operates and locks.

> The SRL relay is slow operate for the same purpose as the OR relay is for slow releasing.

A holding circuit is connected to the CON1 and CON2 relays and ground is connected to the RL lead of the connector to the terminating sender.

> Ground connected to the RL lead causes the sender to release the connector which in turn releases the marker.
>
> With the incoming trunk cut through the T relay is flashed at the rate of 120 interruptions per minute. This causes interrupted low tone to be connected from the OFT lead to the A condenser, as an overflow signal to the calling subscriber.

LAST LINE OF TERMINAL HUNTING GROUP - OS 519

If the marker seizes the last line of a terminal hunting group on first test, this line will have an RF cross-connection and the GT relay test will be made with the tip and ring connected together. Failure of the GT relay to release will produce a trouble record and connection will be made to the line on second trial, if the last line is again selected. This is possible on second trial because the operation of the TR2 relay cancels ground test with the CN relay down.

If on a second trial the marker seizes a PBX line and the recycle on GT failure causes hunt progress to the last line of the group, the GT test for the last line will be made on a loop basis because of the HF2 and HF3 relays being operated. Failure of the loop test, on retest, will reroute to overflow.

The CCT-PBX Jack feature does not operate the CCT relay on the last line because the HF1 relay will not be operated.

TERMINAL HUNTING WITHIN A TWENTY BLOCK

OS 527

A group of consecutive numbers within a twenty block may be arranged for terminal hunting by cross-connecting the NF punchings at the block relay frame, of all lines of the group except the last line, to HF-0 to 19 punchings instead of to RF-0 to 19 punchings, and by cross-connecting the NC leads at the block relay frame, the S and M-1 leads at the line distributing frame, and the T and R leads at the main distributing frame as described for direct lines. In this case the HF punching used for a line corresponds to the location of the line by line choices, as described for the RF punchings.

All of the cross-connections for the last line of the group are made as for a direct line.

Since lines in terminal hunting groups are expected to carry heavy loads, it is desirable to distribute such lines as evenly as possible over the line choices and quarter-choices, in order to keep the line choices the same size if possible, to prevent excessive overflow signals because of an unbalance of load on junctors and links, and to cause as little disturbance as possible in a PBX group in case a line choice must be put out of service for any reason.

The arrangement used for distributing lines is such that any number may be connected to any line choice. This is of advantage in connection with the transfer or working lines from one line choice to another without making number changes; for balancing traffic, for party line fill and for class of service change reasons.

With cross-connections made as above, a call to a terminal hunting line progresses for a call to an individual line, up to operation of relays LE-1 to LE-12 for selection of the line. The LE-1 and LE-2 relays connect the windings of the HT relays to the NF leads to the number group connector circuit. There are HT relays in the marker, designated 0 to 19, for use in recording terminal hunting indications for the 20 lines of a selected twenty block. Relays LE-3 to LE-6 connect ground to the HF leads to the number group connector circuit.

Consequently operation of relays LE-1 to LE-6 causes the HT relays corresponding to terminal hunting lines in the selected twenty block to operate. The operating path for an HT relay is traced from battery at normal contacts of the XT-2 relay, winding of the HT relay, operated contacts of the LE-1 or LE-2 relay, normal contacts of the corresponding L relay, to the NF lead to the number group connector circuit, operated contacts of the MCB connector relay and the operated twenty block relay to the NF punching, cross-connected to an HF punching, which is closed through the MCB connector relay to an HF lead to the marker, through operated contacts of relays LE-6, 5, 4 and 3 as required, to ground at the LE-3 relay.

In calls completed on a light traffic basis, operation of the LE relays during the test for crossed NS leads does not operate the HT relays as at the time this test is made the twenty block relay has not been operated.

With the required HT relays operated as above, the call progresses up to operation of the TLT relay. At this point the S relays for busy lines have been operated.

If the called number is idle, operation of the TLT relay causes the corresponding L relay in the marker to operate as before, the operated HT relays having no effect. The call is completed in this case as for a call to an idle individual line, except that the HT relay corresponding to the called number releases when the L relay operates, any other operated HT relays release when relays LE-1 to LE-6 release, and upon operation of the required LC relay, the HF relay operates instead of the RF relay. Contacts of the HF relay replace the RF relay contacts for operating the RC relay. The HF relay operates the HF1 relay and connects ground to the HF lead to the incoming link and connector circuit as a terminal hunting indication for use with certain types of test trunks. The HF relay releases in disconnection when the operated L relay releases, in turn releasing the HF1 relay.

If the called number is busy, the L relay does not operate as above as its path is open due to the corresponding S relay being operated. In this case ground from the TLT relay is passed along by the operated S and HT relays to the next higher numbered set of relays. These in turn carry forward the circuit if the associated line is a busy terminal hunting line.

If an idle line is found in the group, the L relay for that line operates and the call continues.

If all the lines of the group are busy, the ground from the TLT relay is passed along to the equipment for the last line, which is wired as a direct line. At this point it is closed through the S relay operated and the HT relay normal, causing the BB relay to operate. The call continues as described for a busy individual line, the incoming trunk circuit being set by the marker to return the busy signal.

CONSECUTIVE END OF BLOCK HUNTING

OS 510, 527

In the preceding case it was assumed that the terminal hunting group described was included within one twenty block. In such a case HT-19 relay in the marker cannot operate as the last line of a terminal hunting group is wired as a direct line.

A group of terminal hunting lines, however, may be extended through additional consecutive twenty blocks, as desired, up to and including the last number of the hundred block which contains the directory number. Such a group may start at any number and end at any other higher number in the same hundred block. It may include 100 lines if the directory number is the first number of a hundred block.

"Consecutive end of block hunting" is the process of transferring the line testing equipment in the marker from one twenty block to the next higher twenty block. The marker causes this type of hunting to take place if it hunts to relay HT-19 and finds it operated, indicating that there are additional lines in the group in another twenty block.

A call of this type progresses as described for a call to a terminal hunting group up to operation of the TLT relay. If an idle line is found in the twenty block associated with the directory number of the group it is selected as before. If all the lines of the group in this twenty block are busy, however, the ground from the TLT relay contacts is extended through operated contacts of relay HT-19, causing the PG relay to operate and disconnecting battery from the windings of the L relays.

An odd numbered HP- relay, numbered one higher than the HP- relays previously used operates and locks and locks the previously even numbered HP- relay and operates the UT relay.

> Relays HP-0 to HP-8 are provided for terminal hunting progress in PBX groups consisting of two or more twenty blocks or parts thereof. An even numbered HP relay was operated as a result of numerical translation, its purpose being to close the required TB lead to the number group connector circuit for operating the twenty block relay on the block relay frame.
>
> End of block hunting requires that the TB lead previously used be opened and that the next higher numbered one be closed. Relays HP-1, 3, 5 and 7 serve to open, respectively, TB leads Nos. 0, 1, 2 and 3, and relays HP-0, 2, 4, 6 and 8 are used to close TB leads 0, 1, 2, 3 and 4.
>
> In order for an end of block hunt to take place the TB lead originally used must have been one of leads Nos. 0, 1, 2 or 3. It could not have been the TB-4 lead, as the marker circuit is not arranged to end of block hunt beyond this point. Consequently the HP relay originally used must have been one of relays HP-0, 2, 4 or 6 and could not have been the HP-8 relay.
>
> End of block hunting does not require any change in the HB relay of the number group connector circuit originally used for the call, as this type of hunting is restricted to one hundred block.

The operated TB relay in the number group connector circuit, the marker circuit TBW, HT, S, TBK, TLT and PG relays release.

> Battery is connected to the windings of the L relays.

The next higher even numbered HP relay in the marker operates and locks, causing the TB relay in the number group connector circuit numbered one higher than the TB relay originally used and the TBW in the marker to operate.

> The TB relay to operate at this time is relay TB-1, 2, 3 or 4 associated with the hundred block originally selected. It operates due to closure of the correspondingly designated TB lead by operation of one of relays HP-2, 4, 6 or 8 respectively.

Marker circuit TBK, TLT and the HT relays, corresponding to terminal hunting lines in the selected twenty block and the S relays corresponding to busy lines operate.

Slow operation of the TLT relay due to condenser timing allows time for the TB, HT and S relays to operate before another attempt is made to select a line.

The call continues from this point, due to operation of the TLT relay. If an idle line is found, it is selected as before. If the group does not extend beyond the selected twenty block and all lines are found busy, the busy signal is returned. If there are additional lines, however, in another consecutive twenty block, the end of block hunt may be repeated, using the next higher odd and even numbered HP relays, due to reoperation of the PG relay with all of the HT relays, including HT-19, and all of the S relays operated. Four consecutive end of block hunts may be made in this manner, for a maximum of 100 lines, provided that the TB lead initially used was TB-0 lead. Otherwise a correspondingly smaller number of end of block hunts is permissible.

With the UT relay operated, testing starts at the first number of the twenty block, regardless of the setting of the units recording relays or TEV and TOD. With the arrangement, whatever the directory number of the group may be, the marker tests consecutive numbers starting at the first sleeve of the block and up to the limit of the group.

In disconnection, all operated HP relays and the UT relay release when the CK-6 relay releases.

SPLIT HUNDREDS
NON-CONSECUTIVE END OF BLOCK HUNTING
OS 527

Ordinarily the twenty blocks in the number group connectors run regularly within the hundred blocks; that is, numbers ending in 00 to 19 are on the relay operated by lead TB-0 from the marker, numbers ending in 20 to 39 are on the relay operated by lead TB-1, etc. However, these assignments can be changed so that any twenty block relay may be operated by any TB lead on any HB relay within the same number group.

This arrangement makes it possible to end of block hunt to any desired twenty block on a non-consecutive basis. It is used to increase terminal hunting groups without making number changes in cases in which consecutive hunting would interfere with numbers assigned elsewhere.

The number group connector circuit and the HB relay therein which are used for a terminal hunting group of this type are those which correspond to the numerical location of the directory number. The TB relays are connected to the HB relay punchings in the order in which the twenty blocks are to be tested, the relay on which the directory number is located ordinarily being connected to operate in its normal location on the HB relay, and the other TB relays involved being connected to operate from the consecutively numbered TB punchings. The numbers of these punchings do not necessarily correspond to the numbers of the TB relays, when split hundreds is involved.

For example, a forty line terminal hunting group, having the directory number 1980 and consisting of line numbers 1980 to 1999 and 1940 to 1959 would use the following twenty block relays from the 1900 hundred block HB relay, by the following transpositions at the block relay frame. Numbers 1980 to 1999 associated with the TB4 relay will be operated from the TB2 punching. This is for the purpose of arranging hunting progress to another twenty block. Numbers 1940 to 1959 on TB2 relay will be operated from the TB3 punching, and numbers 1960 to 1979 on the TB3 relay becomes associated with TB4 punching.

When non-consecutive twenty blocks of numbers are arranged for terminal hunting, it is necessary for the marker to use a split hundreds relay. A maximum of twenty of these SH relays are provided for each marker.

The marker normally regards a block of 100 consecutive numbers as a unit and provides an ST punching and an HB punching (Fig. 3) whereby the hundred block, located in one number group connected, may be seized. In this case, however, and in other cases, a block of 100 numbers is considered as five separate twenty blocks and a split hundreds relay (SH) is provided.

For a block of 100 numbers for which a split hundreds relay is provided, the ST punching of Fig. 3 in the markers is cross-connected to the SH punching of the assigned SH relay instead of to an NG-ST punching. The associated HB punching of Fig. 3 is not cross-connected. The SH relays carry four leads from each of the five TB relays in the marker, so that with a marker circuit TB relay and an SH relay operated, four punchings at the SH relay which are individual to the 20 numbers indicated, are made effective.

Of these punchings, SH-ST is connected to the NG-ST punching corresponding to the number group connector circuit required, SH-HB is connected to the required NG-HB punching, SH-TB is connected to one of punchings TB-0 to 4 of Fig. 11, and AL is connected to NAL of Fig. 11, when non-consecutive end of block hunting is required.

The cross-connection from SH-TB to one of punchings TB-0 to 4 (Fig. 11) corresponds to the location of the twenty block for the purpose of non-consecutive end of block hunting and consequently does not necessarily correspond to the regular location of the numbers. For example, in the case previously cited, this cross-connection for the block 1980 to 1999 is made to TB-2, whereas its regular location would call for TB-4.

With cross-connections made as above, and 1980 the directory number of the above terminal hunting group recorded in the marker, operation of a marker circuit FH relay and an HN relay causes the SH relay for the indicated hundred block to operate.

The NFL and NAL relays operate causing the regular operating path for the even numbered HP relays to be opened.

It is necessary to open this path as the TB lead required may be a lead other than the one indicated by the regular numerical location of the twenty block.

Marker circuit HPE relay operates and locks connecting battery to the ST lead and ground to the required HB lead to the number group connector circuit.

The required even numbered HP relay in the marker operates closing the corresponding TB lead to the number group connector.

The ST and HB leads closed as above, and the HP relay operated for closing a TB lead are selected due to the cross-connections from the SH relay contacts. Use of the split hundreds relay permits any or all of these leads to be selected as required.

The leads selected for twenty blocks which have not been moved from their regular locations are the same as those which would be used if the hundred block were not split. This is the case for twenty blocks which include the directory number of a terminal hunting group arranged for non-consecutive end of block hunting, except in cases in which such a twenty block must be moved to a lower numbered HB relay contact in order to provide the required number of lines.

For twenty blocks which have been moved from their regular numerical locations and have been associated with HB relay contacts on a non-consecutive basis, one or more of the selected ST, HB and TB leads are different from those which would otherwise be used. This is the case for the second and in most cases for other twenty blocks of groups arranged for non-consecutive end of block hunting. While such numbers are not expected to be dialed by subscribers, it is necessary that the marker be cross-connected so that they can be reached from the test desk, or by error of dialing.

From this point the circuit advances as for a regular call. If all lines in the first block are found busy, non-consecutive end of block hunting takes place as described for consecutive end of block hunting, except that the twenty blocks used as described above are not in numerical order. A total of five twenty blocks may be used for a terminal hunting group of this type. The UT relay is used to start the test at the first line of second and other twenty blocks.

In disconnection, the HPE relay releases when the CK-7 relay releases. Release of the recording relays releases the SH relay, which in turn releases the NAL and NFL relays, the operated HP relays, and the UT relay if operated.

PBX ALTERNATE NUMBER GROUP ALLOTTER

OS 527

The function of this circuit, which is included in Fig. 11, is to distribute calls for a large terminal hunting group over two number group connectors. It is ordinarily used with groups having such a calling rate that more than 1000 busy hour calls would otherwise be delivered to one number group connector. It may also be used to distribute calls to two number group connectors to reduce the hazard in case one circuit should be made unavailable due to trouble.

Each group of lines in a number group, forming part of an allotted terminal hunting group, may be arranged for four consecutive or non-consecutive end of block hunts. Consequently a terminal hunting group of this type may include a maximum of 200 lines, 100 in each of the number groups.

In each number group, the last line of each allotment is cross-connected as a direct line and the other lines are cross-connected for terminal hunting.

No other individual line or PBX may be assigned a number in the 20-block which contains the directory number of a PBX allotment. Neither can jump hunting be included in an allotted PBX. This is because on an allotted PBX regardless of the directory number location in the 20-block, testing always starts on the first line of the 20-block.

Approximately 50 per cent of the terminating traffic to an allotted terminal hunting group is started in each of the number groups involved. If the marker tests the lines in one number group and finds all of them busy, however, it advances for testing the lines in the other number group before returning a busy signal. In order to decrease the number of times that the marker must advance in this way and thereby decrease holding time, a terminal hunting group used exclusively for terminating traffic should have an equal number of lines in each number group. For the same reason, in a two-way group the number of lines likely to be busy on originating traffic should be considered in assigning the lines so that each number group will have an equal number of lines available for terminating calls.

It should be remembered that all lines associated with a large PBX are not always included in the ISG (incoming service group), but are divided between the ISG and the OSG (outgoing service group) according to the needs of the PBX. Therefore those lines that are used exclusively for the OSG are not included in the terminal hunting group on a regular call, but can be included on number checking calls. When lines are not to be included in the ISG the term "No ISG" will be used in traffic letters and in service orders.

A split hundreds relay must be provided for the group of 100 numbers in a number group. This is the 'A' allotment which includes the directory number of an allotted terminal hunting group. This is necessary in order to operate relays in the allotter circuit, regardless of whether or not the non-consecutive end of block hunting feature is involved. If the second, or 'B' allotment requires non-consecutive end of block hunting, then a second SH relay is required and becomes associated with the group of 100 lines in the second number group.

As described under non-consecutive end of block hunting, when a split hundreds relay is provided, the ST punching of Fig. 3 for the block of 100 numbers is cross-connected to the SH punching of the assigned SH relay. The associated HB punching of Fig. 3 is not cross-connected.

For 20-block containing the directory number ("A" allotment) of an allotted terminal hunting group, the SH-ST, SH-HB and SH-TB punchings at the SH relay contacts are cross-connected respectively to a group of punchings ALC-ST, ALC-HB and ALC-TB of Fig. 11. Punching AL at the SH relay is connected to punching AL of Fig. 11 if the terminal hunting group does not consist of free lines; otherwise it is connected to AF. It is assumed in this case that terminal AL of Fig. 11 is used.

Only the 20-block having the directory number and always appearing in the "A" allotment will be wired AL (allot). All other succeeding 20-blocks in the "A" allotment, and if a split hundreds relay is required in the second allotment, shall be wired NAL (non-allot).

Where an allotted terminal hunting group has an OSG and are required in the ISG for number checking, these lines should be assigned to the number group containing the directory number because this number group is always seized first on number checking calls, and marker holding time will consequently be decreased by this procedure. However, it might be found advantageous to assign them to the number group not containing the directory number for the following reasons.

(A) The outward lines (OSG) might be listed as PBX lines which are cut through for night service. In this case the night lines require location in a twenty block that is cross-connected NAL (no allotter) so that the lines can be reached directly and the marker will recognize units registration. The marker does not recognize the units digit registration in the first twenty block of the 'A' allotment but instead starts at L-0 for terminal hunting. For this reason, night service lines must be put into twenty blocks other than the one containing the directory number, of the 'A' allotment or into any twenty block of the 'B' allotment.

(B) In an allotted PBX the group of numbers containing the directory number must be seized first on no-test and no-hunt traffic. Failure to assign lines in this manner will result in seizure of a wrong line of the PBX on these calls.

A maximum of (20) twenty blocks may be cross-connected to the allotter, this limit being determined by the sixty-contact AL-1 and AL-2 relays which carry 20 sets of ST, HB and TB leads. These relays are operated alternately on successive calls and serve to distribute the load, on the average, over the two number groups associated with each of the allotted terminal hunting groups. Also, if all lines in one number group are found busy, the setting of these relays is changed so that the other lines ("B" allotment) may be tested.

At the AL-1 relay, the AL-1-ST, HB and TB punchings corresponding to a group of ALC punchings connected as above are cross-connected respectively to the NG-ST and NG-HB punchings of Fig. 7 for the number group having the "A" allotment and one of terminals TB-0 to 4 of Fig. 11, the punchings used corresponding to the location of the 20-block which contains the directory number.

At the AL-2 relay, the associated AL-2-ST, HB and TB punchings are cross-connected respectively to the NG-ST and NG-HB punchings of Fig. 7 for the number group having the "B" allotment and one of terminals TB-0 to 4 of Fig. 11 which correspond to the location of the first 20-block of the allotted group in the alternate number group. This may be any available 20-block in the number group and may consist of numbered or coded lines.

At the SH relay for the block of 100 numbers ("A" allotment) containing the directory number, the punchings for 20-blocks which are not part of the allotted group are cross-connected to correspond with the locations of the 20-blocks in the number groups, SH-ST, SH-HB and SH-TB being connected respectively to the required NG-ST, NG-HB and TB-0 to 4 punchings. For these 20-blocks AL at the SH relay is connected to NAL of Fig. 11.

The ALW and ALZ relays are operated on one call and released on the next call. They in turn control the operation of the AL-1 and AL-2 relays.

When the CK7 relay operates for the first call the ALW relay operates and locks and the ALZ relay is short-circuited, this operates the AL-1 relay.

When the CK7 relay releases for the first call the ALZ relay operates and the AL-1 releases.

When the CK7 relay operates for the second call the ALW relay releases and a holding path is closed for the ALZ relay, this operates the AL-2 relay.

When the CK7 relay releases for the second call the ALZ relay releases causing the AL-2 to release.

> The above operations take place for each two calls, regardless of whether or not an allotted terminal hunting group is involved. On calls to such groups, alternate operation of the AL-1 and AL-2 relays distributes the traffic over the two number groups. With cross-connections made as above such a call progresses as for a regular call through numerical translation.

Operation of a marker FH and HN relay causes the required SH relay to operate followed by the operation of the AL and NFL relays, this opens the operating path of the BB relay.

> The operating path of the BB relay is opened to prevent the transmission of a busy signal in case all lines in the number group tested first are found busy. The marker is arranged to test the other group of lines in such a case.
>
> The regular operating path for the even numbered HP relays is opened.

The HPE relay in the marker operates and locks connecting battery to the ST lead to the required number group connector circuit and ground to the required HB lead to the number group connector.

The ST lead closed is determined by whichever of relays AL-1 and AL-2 is operated. This also applies to the HB and TB leads.

The required even numbered HP relay in the marker and the corresponding TB lead to the number group connector is closed. The marker UT then operates.

The UT relay operated causes testing to start at the first number of the 20-block. If the directory number of the group is not the first number of a 20-block, the preceding numbers in the 20-block can consequently be included in the group. They cannot, however, be used for any other subscribers. Similar conditions apply to the first 20-block of the group in the alternate number group. In this case if the lowest number is not the first number of the 20-block, the lower numbers cannot be used.

If the first lines of a twenty block are not to be used for service, because of an allotted PBX, they must be made busy by cross-connecting the sleeve terminals on the V.L.D.F. to the ground terminal. In addition, an NF cross-connection must be made for each line, at the block relay frame. These NF cross-connections may be installed arbitrarily to any terminals in the HF field because they are only needed to direct the hunting past the unused lines. It is not necessary to make any NC cross-connections in this case.

The call continues from this point. The marker progresses through end of block hunt until a busy last line is encountered, unless an idle line is found. If an idle line is found, it is selected as before. If all the lines of the terminal hunting group in the selected number group are busy, the lines in the other number group are connected for test as follows, due to operation of the TLT relay with the S relays operated, the HT relay of the last line normal and the AL relay operated.

Marker circuit ALA relay operates and locks causing the HPE, HPS and UT relays to release. This removes battery from ST lead, ground from the HB lead and opens the TB lead to the number group connector circuit.

The ALZ operates, if normal, or releases, if operated and the AL-1 or AL-2 relay, whichever is operated, releases.

Removal of battery from the ST lead releases the number group connector circuit which in turn removes ground from the CK lead to the marker, causing the NK relay to release. Release of the NK relay restores the marker to its conditions previous to seizure of the number group. Release of relays LE-1 to LE-6 and LE-8 to LE-11 causes the LE relay to release.

The ALB and HPE relays operate and lock, the ALW relay operates, if normal, or releases if operated, and the AL-1 or AL-2 relay operates.

> The AL-1 or AL-2 relay to operate at this time is the one that was normal while the first group of lines was being tested.

The ST and HB leads to the number group connector are closed.

An even numbered HP- relay operates causing the operation of the UT relay and closing the corresponding TB lead to the number group connector.

> Closure of the ST, HB and TB leads as above causes the other number group to be connected to the marker. The lines in this number group associated with the terminal hunting group are tested as before, end of block hunting taking place if necessary. If all of the lines are busy, the BB relay operates and the call continues as described for a busy line.
>
> In disconnection, the ALA, ALB and HPE relays release when the CK-6 and CK-7 relay releases. Release of the recording relays releases the SH relay, which in turn releases the AL and NFL relays, the operated HP relays, and the UT relay.
>
> Twenty-blocks in the first number group connector in an allotted group, other than the one including the directory number, have their ST, HB and TB punchings at the SH relay connected to NG-ST, NG-HB and one of punchings TB-0 to 4. The AL punching is connected to NAL.
>
> If a number in one of these blocks is called, the HPE relay operated due to the NAL cross-connection, as in non-consecutive end of block hunting, permits closure of the number group connector leads and the completion of the call on an end of block hunt basis up to the last line of those in the number group. Allotment to the lines in the other number group, however, does not take place.

FREE LINES

Lines which may be called free of charge are grouped in special twenty blocks in the number group connectors. If any line in a 20-block is a free line, all in that block must be free. If any 20-block in a hundred block consists of free lines, a split hundreds relay must be furnished for that hundred block. The SH-ST, HB and TB punchings at the split hundreds relay are cross-connected to ALC punchings for free line 20-blocks that are allotted, or to the NG-ST, NG-HB and TB-0 to 4 punchings corresponding to the locations in the number groups for free line 20-blocks that are not allotted. The AL punchings at the SH relay for the free line 20-blocks are cross-connected to NAF in Fig. 11, if the free lines are not allotted, and to AF if they are allotted. For non-free line 20-blocks on a split hundreds relay the AL punching is cross-connected to AL or NAL.

Consequently, operation of the SH relay on a call to a free line causes the FL relay to operate. The FL relay operates relay NAL or AL, depending upon whether the AL cross-connection is made to NAF or AF. In addition, it prepares a path which is effective when the FS relay operates for operating the TC relay at the same time that the RC relay is operated.

The TC relay operates the marker circuit TC-1 relay and connects ground to the TC lead to the incoming link and connector circuit for operating the TC relay in the incoming trunk circuit which cancels supervision and thus prevents charging. Since the combination of TC with RC and RV are used for overflow signal, tip party lines cannot be free lines.

In this case the operating path of the GT-1 and GT-2 relays will include the operated contacts of the marker circuit TC and TC-1 relays, as a check on the trunk circuit relay.

Supervision is not canceled as above on calls to free lines from manual and toll trunks as on such calls due to corresponding cross-connections at the incoming link and connector frame, the MAN and TOL relays operate respectively and the FS relay does not operate.

If the NAL relay is operated as above, it operates the HPE relay, permitting closure of the number group connector leads and completion of the call on a non-allotted basis. End of block hunting may be used, if required.

If the AL relay is operated, it also operates the HPE relay and it transfers the L relay operating ground (from HT-19 normal) from the BB relay to the ALA relay, making the allotter feature effective as described for allotted non-free lines.

In this connection, twenty blocks representing numbers which are not involved in non-consecutive end of block hunting, allotment, or free calls may appear at a split hundreds relay because other blocks in the same hundred require that the hundred be split. The SH-ST, HB and TB punchings for such twenty blocks are connected to the NG-ST, NG-HB and TB-0 to 4 punchings corresponding to the locations in the number groups. The AL punchings are connected to NAL, permitting the completion of calls for these numbers.

Operation of the FL relay plus the NFL relay because of trouble, blocks the call by opening the HB lead to the number group. Operations of the AL relay plus the NAL relay because of trouble operates the X relay and blocks the call.

The following chart summarizes the previous information relating to the AL punching on the split hundreds (SH) relay.

	Punching Cross-Connection	Fig. 11 Relays Operated
Non-Consecutive End of Block	AL to NAL	NAL and NFL
PBX Allotted		
Directory number 20-block	AL to AL	AL and NFL
Other than directory number 20-block	AL to NAL	NAL and NFL
Free Lines		
Free line 20-block not allotted	AL to NAF	FL and NAL
Free line 20-block allotted	AL to AF	FL and AL

CHAPTER 8

SECTION 5

MISCELLANEOUS INFORMATION AND FEATURES

Line Choice Connector Circuit	SD-25275-01
Number Group Connector Circuit	SD-25276-01
Terminating Marker Circuit	SD-25283-01
Overflow Register Circuit	SD-25381-01

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CODED LINES OS 528

Coded lines are subscriber lines which are assigned to line link verticals, but do not have directory numbers and which, therefore, can not be dialed. They are in excess of the 10,000 lines required for the directory numbers of an office and are used for the purpose of increasing the size of terminal hunting groups. Incoming calls may reach these lines on a terminal hunting basis only. Outgoing calls are made in the regular manner, message registers being provided on coded lines for this purpose.

Each coded line is associated with the equipment at the block relay frame and the line distributing frame (LDF) as already described for the regular lines. They are assigned in groups of one hundred to each number group, and are selected by means of the HB-24 hundred block relay.

The coded lines are designated and assigned to the number groups, as follows:

No. Grp.	Coded Lines	No. Grp.	Coded Lines	No. Grp.	Coded Lines	No. Grp.	Coded Lines
0	A 0000/99	6	G 0600/99	12	N 1200/99	18	U 1800/99
1	B 0100/99	7	H 0700/99	13	P 1300/99	19	V 1900/99
2	C 0200/99	8	J 0800/99	14	Q 1400/99	20	W 2000/99
3	D 0300/99	9	K 0900/99	15	R 1500/99	21	X 2100/99
4	E 0400/99	10	L 1000/99	16	S 1600/99	22	Y 2200/99
5	F 0500/99	11	M 1100/99	17	T 1700/99	23	Z 2300/99
						24	AA 2400/99

It is standard for these coded lines to start at the HB-4 relay on block relay frame No. 12. Each group of one hundred lines is associated with one HB-relay and the five TB-relays in the usual manner, with the alphabetical designation appearing on the center TB-relay of the group. The HB-24 lead from each number group is connected to the HB-relay for the group of 100 lines assigned to that number group. The five TB leads for the coded group HB-relay are common to the five TB leads in the associated number group connector.

A terminal hunting group may include one or more directory numbered lines and the coded lines as required up to the capacity of the extra hundred block (HB-24). Coded lines can only be associated with terminal hunting groups, whose directory numbered lines appear in the same number group.

To gain access to coded lines, there are three methods provided as follows:

(A) Through "Jump Hunting" from any directory line in the associated number group other than an allotted P.B.X.

(B) By direct connection to the HB-24 hundred block relay, when an allotted P.B.X. has all coded lines in the "B" allotment.

(C) By "Jump Hunting" beyond the first 20-block on an allotted P.B.X.

In connection with method (B), when coded lines are included in an allotted P.B.X., it is the general practice to assign them to the "B" allotment, the AL2-HB punching on the AL-2 relay being cross-connected for the number group HB-24 hundred block relay.

JUMP HUNTING TO CODED LINES

By means of special cross-connections on the block relay frame associated with each number group connector, the marker may be made to furnish the type of terminal hunting progress known as jump hunting. This feature is used principally to increase the size of a terminal hunting group, without changing the directory number, when the consecutive numbers following the group have already been assigned to subscribers. It can also be used when a terminal hunting group is to be established and there are not enough regular numbers in the number group.

The jump hunting feature reduces the necessity of leaving spare terminals following lines or groups which may grow, but since its use increases marker holding time, this factor should be considered.

The marker can jump hunt after end of block hunting and end of block hunt after jump hunting, but regardless of which sequence occurs only one jump hunt is possible in one call. The marker can not jump hunt on a call using the P.B.X. allotter, because testing starts at zero terminal. No more than four end of block hunts should be used in connection with jump hunt, or else the marker may time-out. Any end of block hunting which occurs after jump hunting must be confined to the 20-blocks associated with the HB-24 relay in the number group.

It has already been stated that coded lines are assigned in groups of 100 to each number group and there use in so far as P.B.X. allotment. These same coded lines are used when jump hunting is necessary and also by means of connection to the HB-24 relay.

Jump hunting permits terminal hunting progress from any regular number to one of the even numbered coded lines within the same number group, whereas end of block hunting permits progress only from the twentieth terminal of a 20-block to the first terminal of another 20-block. Jump hunting is intended for use with the smaller terminal hunting groups, which are so located in the 20-blocks that they could not be arranged for end of block hunting without changing their locations.

In order to jump hunt, the last line of the numbered group containing the directory number, which is usually some line other than the twentieth of a 20-block, must have its NF and NC cross-connection disconnected from their present location and reconnected to the JF and JC fields on the block relay frame. Also, the S and M cross-connection on the LDF are disconnected. By these disconnections this line loses its association with the line link vertical, because it is now used to indicate to the marker the jump hunt information.

The first coded line reached by the jump hunt replaces the numbered line. Therefore, it will be cross-connected for the line link vertical information previously used for the numbered line it replaced.

The NF punching for the jump hunt line is cross-connected to one of five strips designated JF-0 to JF-4, for the same number group, in the jump hunting fields on the block relay frame. The numerical designation of the JF strip used corresponds to the location of the 20-block, in the HB-24 hundred block to be jumped to which contains the start of the added numbers.

The NC punching is connected to one of punchings JC-0, JC-2, etc., to JC-18, to indicate which of the even numbered terminals in the twenty block is to be the first of the added numbers. Only the even numbers are made available as start points in jump hunt. This is because two coded lines must be added to gain one line or three coded lines to gain two lines, etc.

It is assumed in this case that the called number is the directory number of a terminal hunting group arranged for jump hunting. The directory number may be any number in a twenty block, and consecutive numbers may be used with it, the last of these being cross-connected for jump hunting.

A call of this type progresses as for a regular call up to operation of the TLT relay. If an idle line is found in the twenty block which includes the directory number, it is selected in normal manner. Otherwise the L relay operating ground is extended, by the S and HT relays operated, to the L relay corresponding to the line wired for jump hunting. This terminal tests idle to the marker as its NS punching is not cross-connected at the LDF. Consequently the L relay operates, connecting ground to the associated NF and NC leads and otherwise functioning as in regular operation.

A marker circuit JF relay, corresponding to the location of the twenty block which contains the added numbers, operates and locks due to closure of ground to the NF lead, which returns to the marker over one of the JF-0 to 4 leads.

> The marker circuit includes five JF relays, designated 0 to 4, used to record a twenty block indication for lines reached through jump hunting. The one to operate is determined by a cross-connection at the block relay frame from the NF punching to a JF punching.

A marker circuit JC relay, corresponding to the start point in the twenty block of the added lines, operates and locks due to closure of ground to the NC lead, which returns to the marker over one of leads JC-0, JC-2, etc. to JC-18.

> There are 10-JC relays in the marker, having even numbered designations from 0 to 18, used to record the start point of the added lines. The one to operate is determined by a cross-connection at the block relay frame from the NC punching to a JC punching.
>
> The marginal XJC relay is connected in series in this path, to detect crossed JC leads. If it operates, due to a trouble, it sticks the circuit. It is assumed for this call that no trouble is encountered and that the XJC relay does not operate.

Marker circuit JHA relay operates, the marker L for first twenty block only releases, the operated HB and TB relays in the number group release and the marker TBW relay releases.

Release of the TB relay causes the operated S relays in the marker to release.

Marker circuit TLT, TBK and L relays release.

The L releases when jump hunt is from other than first twenty block.

The JHB relay in the marker operates and locks.

The JHB relay is slow operate to allow time for the number group connector HB and TB relays to release before closing the HB and TB leads required for coded lines, to prevent interference.

With the JHB relay operated, the contacts of the TLT relay are connected under control of the JC relay operated, to an even numbered set of L, S and HT relays corresponding to the start point of the coded lines. This has no relation to the number recorded in the marker, as the path originally closed through the units recording relays and TEV or TOD is now open at contacts of the JHA relay. The JHB relay also closes in part the locking paths for the L relays.

Due to closure of the HB-24 lead the HB-24 relay in the number group connector operates.

The HB-24 lead to the number group is connected to the HB relay for the 100 coded lines and is known as the HB-24 relay. The HB-24 relay is designated in accordance with its alphabetical location for its number group connector.

An even numbered HP relay, corresponding to the required twenty block, operates.

The HP relay to operate is controlled by the JF relay operated. Relay HP-0, 2, 4, 6 or 8 operates under control of relay JF-0, 1, 2, 3 or 4 respectively.

The required number group connector circuit TB relay and the marker circuit TBW and TBK relays operate.

Upon the release of the L relay corresponding to the terminal wired for jump hunting and the operation of the JHB relay, given above, relays LE-1 to LE-12 operate, operating relay LE and otherwise functioning as in regular operation. Consequently, operation of the number group connector circuit TB relay associated with the coded lines causes the HT relays for terminal hunting lines in the twenty block to operate. The S relays for busy lines also operate.

Operation of the TBW relay, with the LE relay operated, causes the TLT relay to operate. The added lines are tested, the start point being determined by the operated JC relay and the corresponding to an even numbered terminal in the selected twenty block.

End of block hunting either consecutive or non-consecutive, may be used after jump hunting, but it must be confined to the 20-blocks associated with HB-24 relay. In this case the last terminal of the 20-block that includes the jump hunted lines is wired as a hunt line, closing an operating path for the PG relay, if all the lines are busy.

Jump hunting may be used after consecutive or non-consecutive end of block hunting. However, not more than four end of block hunts should be used in combination with a jump hunt, or else the marker may time out.

The last coded line of the group is wired as a direct line, causing the BB relay to operate and function as before if no idle line is found.

BRIDGED SLEEVE CROSS-CONNECTIONS

For certain types of service it is necessary to have two different numbers common to one line link vertical which will involve bridged sleeves. They may be two numbered lines in common or one numbered line and one coded line in common. Such a termination consequently has associated with it two sets of 20-block relay contacts, and may be selected at either location.

In some offices there are no message registers associated with coded lines and, therefore, a numbered line must be used for the purpose of providing a message register. For this situation the LDF cross-connection is split. A jump hunt to a coded line also involves the split cross-connection at the LDF.

In the latest type crossbar office, the terminating markers are designed to associate a test bureau trunk with a coded line, when indicated by the Test Deskman. In the earlier type crossbar office this is not possible, and, therefore, a numbered line must be bridged to each coded line when connected for service so that the test bureau may have access to coded lines for test purposes. The numbered lines bridged to, need not be in numerical order, nor in hunting sequence, because they will be wired as individual lines at their block relay frame. For this reason, these bridged numbered lines are not restricted to the same number group connector and can be any number in the office.

JUMP HUNTING TO DIRECTORY NUMBERED LINES

In offices where coded lines are not furnished and jump hunting is required, the procedures for cross-connecting the numbered line for jump hunt are the same, as already described. The marker functions too, are the same.

The only difference is in the selection of the HB relay connected to the HB-24 lead in the number group. Instead of assigning a group of 100 coded lines to each number group for jump hunting, a group of 100 regular directory numbered lines are assigned for this purpose. Therefore, one of the HB relays associated with the regular directory numbered series within the number group is connected to the HB-24 lead and considered the HB-24 relay for jump hunt.

Since the HB-24 relay will have numbers in the regular numbered series, it may be used for numbers called directly as well as for numbers jumped to under this arrangement one HB relay in each number group can be selected from either of two locations, from the FH relay in the regular numbered series and from the HB-24 lead.

CHANNELS BUSY CONDITIONS

As described under "Line Junctor Distribution" in an office having the maximum of 10 incoming groups and 20 line choices, there are 10 line junctors connecting each pair of incoming frames to each half-choice. In this case the distribution is such that for each junctor the vertical number on the incoming secondary or extension switch is the same as the number of the line choice to which the junctor is connected, and the vertical number at the line link secondary switch is the same as the number of the incoming group at which the junctor originates. Line junctors always connect correspondingly numbered switches on the incoming and line link frames.

A similar condition exists in an office having 10 incoming frames and 10 line choices. Here again there are 10 line junctors connecting each incoming frame to each half-choice. In a like manner the vertical number of the incoming secondary switch is the same as the number on the line choice to which the junctor is connected, and the vertical number at the line link secondary switch is the same as the number of the incoming frame at which the junctor originates.

In both of the above cases, every vertical on the incoming frames and on the line link frames are connected. The 10 junctors available for a call are tested on a first attempt to select a channel and no additional junctors are available in case no idle channel is found on this attempt.

If the number of incoming frames or incoming groups is less than the above limits, the higher numbered line link verticals in each switch, for which there are no correspondingly numbered incoming frames or incoming groups, can not be connected in the numerical relation previously given. In a similar manner, if the number of line choices is less than these limits, the higher numbered incoming link verticals in each switch, for which there are no correspondingly numbered line choices, can not be connected in this way. As many of these verticals as possible, however, on the line link and incoming link frames, are connected for additional line junctors. These additional junctors are distributed, in as nearly equal parts as possible, over all the frames, and are used in second or later attempts to select a channel when all channels available for a first attempt are found busy.

The channels available for successive attempts are divided into a maximum of four subgroups designated first to fourth. In any installation, the first subgroup includes the 10 junctors connected in the standard numerical relation. If there are additional junctors, they are placed in the second, third or fourth subgroups as required. Since the relays associated with subgroups two and three are not arranged for operation with pattern relays, these subgroups are used only in installations in which they may be fully equipped with 10 junctors each. The fourth subgroup may be partially equipped, being arranged for use with pattern relays for blanking out equipped positions.

As described under "Testing the Line Junctors," each LJA and LJB relay in the line choice connector circuits is associated with 10 line junctors, the LJA relays being used with the lime junctors which terminate at the line link frames of the "A" half-choice (A and B frame) and the LJB relays being used with the junctors which terminate at the frames of the "B" half-choice (C and D frame).

There is an exception to this rule in offices in which certain line link verticals can not be connected to juntors because the number of incoming frames are fewer, in proportion, than the number of line choices. In such offices some of the LJ relays have less than 10 junctors associated with them.

On a first attempt to select a channel with the JGA relay operated, the LJA or LJB relay used corresponds in number to the number of the incoming frame or incoming group at which the calling trunk appears, and also corresponds to the number of the line link secondary verticals, in each switch, to which the associated junctors are connected. In this case the incoming frame used for the call causes the operation of the required LJ relay by connecting ground to a JR lead corresponding in number to the incoming frame or group involved. This causes the operation of one of relays JA-0 to JA-9 or JB-0 to JB-9 in the marker, these relays controlling the operation of the LJA and LJB relays.

The paths to operate the JA and JB relays as above involve cross-connections from punchings JGA-0 to 8 at the JGA relay to correspondingly numbered JR punchings at the HCA and HCB relays. These cross-connections are placed up to the number of the highest numbered incoming frame or group and control the line junctors wired in the standard numerical relation. This information, then covers what is considered to be the first choice line junctors.

The attached chart illustrates the relationship of line junctors for all possible combinations of incoming frames or groups and line choice half-choices. This chart indicates the total number of line junctors from each incoming link frame or group to each half-choice. It shows the division of these line junctors into subgroups, where the testing of subgroups may start and the order in which they will be selected before the overflow signal is returned.

To operate these different combinations a cross-connection diagram for fig. 18 is provided for the A to H, GA to GE, STA to STE, ONG and G punchings. These cross-connections will give the proper sequence for testing the subgroups in accordance with the particular pattern.

A second cross-connection diagram is furnished for each combination, to operate the required marker JA or JB relay for each of the existing subgroups. It provides the pattern for the operation of the marker line choice auxiliary relay LCA and the JP pattern relays. This involves the following combinations of figures for cross-connection.

FIGURE NO.	PUNCHINGS		FIGURE NO.	PUNCHINGS
15	JR-0 to 9	to	18	JGA, B, C, or E
15	LIL or RIL	to	18	IL-0 to 9
18	PNA	to	17	JPN
12	LC-0 to 18	to	21	LCA-0 to 8
21	J-0 to 9	to	17	JP-0 to 8

A third cross-connection diagram is furnished for each combination for blanking out line junctor locations in the marker that are not available for test, by the connection of AB-0 to 9 to LJ-0 to 9 punchings in fig. 17. It also indicates the cross-connections at the line choice connector frame, between figures No. 2 and No. 3 for the JA-0 to 9 and JB-0 to 9 punchings. This is because all combinations for the line choice connector LJA or LJB relays for subgroup "E" can not be gained in the marker.

6X6 OR 6X12 PATTERN

The above caption indicates that the following information applies to either a job consisting of 6 incoming frames and 6 line choices or one consisting of 6 incoming groups and 12 line choices.

The 6X12 pattern will be the one described in this text.

When incoming frames are paired, and arranged to work as a group, a secondary extension frame must be provided for each incoming frame. Each vertical on the secondary switches is multiplied to its correspondingly numbered vertical on the secondary switches of its mate frame. These verticals are identified as the 0 to 19 left verticals. In addition, each vertical on the secondary extension switches is multiplied to its corresponding numbered vertical on the secondary extension switches of its mate frame. These verticals are identified as the 0 to 19 right verticals. Thus 400 line junctors are provided for handling calls to the 12 line choices.

The junctors at the line link frames are always paired, two line link frames are known as a half-choice and four are known as a line choice. Consequently, a 12 line choice job will consist of 24 pairs of line link frames or 24 half-choices.

The 400 junctors of each incoming group must be distributed so that each pair of line link frames will have the same number of junctors from each incoming group. In the 6X12 pattern the 400 junctors from an incoming group must be divided among 24 half-choices, resulting in 16 or 17 junctors being available between frames. The first or "A" choice junctor subgroup must always have 10 junctors and the extra junctors, numbering less than 10 are installed in an "E" choice junctor subgroup. Only 5 of these extra junctors are used in this "E" subgroup and thus only 2 pattern relays are required. No effort is made to use the remaining 1 or 2 junctors since their use would require an additional junctor subgroup plus 6 more pattern relays.

Either of these jobs require 6 LCA relays for pattern selection. Both jobs require 2 pattern relays for blanking out channels when the "E" subgroup is tested and both operate the JPN relay when the "A" subgroup is tested.

ALL CHANNELS BUSY

IN "A" SUBGROUP

In this size job the marker always starts the channel test in the "A" subgroup. At this time the RT, RTA, RTA', JGA and OVA relays are operated. Assume now, that when the TKT relay operates, no channel relay can operate because enough AB or LL relays are operated to block the selection of a channel.

Marker circuit PGT relay operates and locks and battery is removed from the windings of the CH relays.

The marker circuit functions to advance into the E subgroup by causing the RTA relays and the JGA relay to release and causing the RTE relays and the JGE to operate. The JA or JB, LIL or RIL, JPN, LJA or LJB, ABS, TKT and PGT relays release.

> The JGE relay operated causes left or right incoming links, as required, to be connected to the marker for tests, it caused the operation of the required LJA or LJB relay, all these in accordance with the requirements of the channels associated with the E subgroup of junctors.

Marker circuit LIL or RIL relay operates.

> Terminals IL-8 and IL-9 at the JGE relay are cross-connected to terminals RIL and LIL respectively as required, so that when junctors from the left half of the incoming secondary are used, left incoming links are used, and when junctors from the right half of the incoming secondary are used, right incoming links are used.
>
> In an office having the number of frames previously given, the junctors of subgroup E are so arranged that right links and junctors are used if the called line is in half-choice "A" and left links and junctors are used if it is in half-choice "B". This arrangement increases the probability of completing the call if the all channels busy condition in the "A" subgroup was caused by busy incoming links.
>
> Consequently, terminal IL-8 being connected to terminal RIL and terminal IL-9 being connected to terminal LIL, causes an operating path for the RIL relay if the HCA relay is operated and for the LIL relay if the HCB relay is operated.

Marker circuit AB relays corresponding to busy incoming links operate from the make busy ground on the sleeves of the links closed over leads OR to 9R or OL to 9L.

Marker circuit JP-0 or JP-1 relays operate.

> The pattern relay required, depends upon the number of the incoming frame group originating the call and the number of the line choice in which the called number is located. Thus the combination from which LCA relay is operated, plus the JP lead which is grounded, plus the wiring shown on the previous diagram will cause one of these relays to operate.

Five marker circuit AB relays operate as a result of the AB punching cross-connections.

Marker ~~count~~ circuits JA or JB relay operates from ground on the JR lead this path being closed over cross-connections from the JGE punching to the JR punching.

The incoming link and connector circuit connects ground to a JR lead of the same number as the incoming group in which it is included. This ground was used in connection with the "A" subgroup of junctors to operate a JA or JB relay (and consequently and LJA or LJB relay) of the same number as the grounded lead. At this time, the JGA relay having been released and the JGE relay having been operated, the ground on the JR lead is used to operate one of relays JA or JB-7, 8 or 9 as required, so that the subgroup "E" junctors can be connected to the marker for test.

As in connecting the "A" subgroup junctors for test, a JA relay operates at this time if the HCA relay is operated, and a JB relay is used if the HCB relay is operated.

Line choice connector LJA or LJB relay operates.

The number of the relay to operate will not agree with the number of the incoming group as it did when the 'A' subgroup of junctors were used, nor will it always agree with the number of the lead grounded by the marker. The relay to be operated will be determined by cross-connections.

Marker circuit AB relays, corresponding to line junctors that are busy in service, and the TK relay operates.

Operation of the TK relay checks for proper operation of the link and junctor connector relays and the horizontal group relays.

Marker OVE and TKT relays operate.

The TKT relay, made slow operate by condenser timing, allows sufficient time for the required AB relays to operate.

From this point the marker advances as for a regular call. A CH relay operates and a channel is selected as before if one is available, and the call continues. If all channels involving the "E" subgroup of junctors are busy, the operation is as given in the following section.

IN "E" SUBGROUP

INDIVIDUAL OR PARTY LINE CALLED

At this point of the call, the RT, RTE, RTE', JGE, OVA and OVE relays are operated. If all channels associated with the "E" subgroup are found busy then the marker circuit PGT and OF relays operate.

If the line selected is the last line of a terminal hunting group (other than an allotted group) or if it is the last line in either number group in an allotted group, the OF relay operates as above because of the RF relay being operated and an overflow signal is returned as for an individual line.

Ground is connected to the OF leads to the line choice connector and the incoming link and connector circuits.

> Ground connected to these leads is closed through the respective circuits and can be connected to the traffic register circuit, to score registers for recording the overflow condition.
>
> In addition, when the OF relay operates, it causes the circuit to function as described in step 6 under "Terminal Hunting Lines, GT Loop Test Failure Following P.B.X. Retest on Second Trial," for the overflow setting in the marker and incoming trunk, and then the release of the marker. The OF and PGT relays release when the CK-6 relay releases. Release of the OF relay releases the TC, RV and RC relays. The corresponding check relays release when ground is removed from their leads by release of the incoming connector. The OVA and OVE relays in fig. 18 release when the LK relay releases.

IN "E" SUBGROUP

TERMINAL HUNTING LINE CALLED - P.B.X. RETEST

If all channels associated with the "E" subgroup of junctors are found busy on a call to an intermediate terminal hunting line, there may be a subsequent line in another line choice served by different junctors and line links to which there is an available channel. The marker is, therefore, arranged to make a first selected intermediate terminal hunting line appear busy and to P.B.X. retest once, when it encounters an overflow condition.

In this case operation of the TKT relay causes the PGT relay to operate and lock as above, and the call continues as described for GT loop test failure, second trial.

Removal of ground from the NF lead by release of the L relay releases the operated LC and HF relays in the marker. Operation of the SG relay opens the start lead to the line choice connector circuit, restoring that circuit to normal, in turn releasing the operated HG relay in the line link and group control circuit.

Removal of ground from the NC lead releases the operated LLG and CA or CB relays in the marker which in turn releases the operated LOG and LG relays, the RC relay, the frame preference relays FP and RS in the incoming link and connector circuit, the operated HCA or HCB relay, the operated JA or JB relay and the LIL or RIL relay. The operated AB and LL relays, the TK relay and the TKT relay release.

Release of the SGA relay causes the LE-1 to LE-12 relays to operate. These relays in turn cause the LE relay to operate, they connect the HT relays to the NF leads and ground to the HF leads and they provide a holding path for the INA relay. The HT relays for terminal hunting lines in the selected twenty block consequently reoperate.

Release of the line choice connector circuit causes ground to be removed from the CK lead to the marker, releasing the LK relay. This in turn releases the RT, OVA, and OVE relays. The RTA relay operates and locks, the circuit checking for the release of the RT, OVA and OVE relays.

When the TKT relay releases, the PGT relay releases. This causes the OF-1 relay to operate and lock.

Due to the above, the circuit is restored to its condition just prior to operation of the TLT relay, except that an LB relay and the LBK relay are operated, five S relays are operated whether or not the corresponding lines are busy, and the OF-1 is operated.

Terminal hunting lines are arranged, as far as possible, so that successive lines are in different line choices. With the line first selected made to appear busy by operation of the corresponding S relay, the circuit is prepared to select another line in the same terminal hunting group if one is available. This takes place upon the release of the LK relay as above, which causes the TLT relay to operate.

From this point the circuits advance as for a regular call if a second idle line is found. In this case, upon reoperation of the LK relay, the RT relay operates, in turn operating the RTA' and JGA relays. Channel testing, consequently, starts at the channels associated with the "A" subgroup of junctors, to the newly selected line, those associated with "E" subgroup also being available if required.

If all channels to the second line in the "A" and "E" subgroups are all found busy, operation of the PGT relay, in testing the "E" subgroup of junctors with the OF-1 relay operated, causes the OF relay to operate. This causes the overflow signal to be returned as described for all channels busy, individual line called.

The operated LB, LBK, and OF-1 relays release when the TBK relay releases.

If an idle line can not be found on the P.B.X. retest, the BB relay operates in the usual manner, causing the marker to advance as for a busy line, operating relays TC and RV but not RC. However, the RC relay was previously operated due to selection of the first line involved. Consequently, the corresponding trunk circuit relay is operated, its locking ground being extended to the marker and holding the RC-1 relay.

This condition causes the trunk circuit to return the overflow signal instead of the line busy signal, and with the marker circuit RC-1 relay operated and the RC relay normal would prevent operation of the GT-1 and GT-2 relays. To avoid blocking the call in this way, contacts of the LBK-1 relay operated short-circuit the checking path through relays RC and RC-1.

If, on the second test for a line, no idle line is found in the twenty block which is connected to the marker, end of block hunting, allotment or jump hunting may take place and a line in any subsequent twenty block in the group may be selected. In advancing to another twenty block under these conditions, momentary release of the TBK relay causes the operated LB, LBK, and OF-1 relays to release.

Consequently, the retest feature is available for use in the second twenty block in case channels busy conditions are encountered and in a similar manner it may be used once in each subsequent twenty block included in the terminal hunting group.

REORDER

If a call through the "B" switchboard can not be completed because of failure to receive a number or for some other similar reason, the reorder code is keyed and a reorder signal circuit is selected at the line link frame. These circuits are connected to line link primary verticals. On a call of this type the marker and its associated circuits function as for a regular call.

Operation of the position disconnect key at the "B" switchboard, however, causes the "B" sender to connect ground to the RO receiving lead. Consequently, the marker RO relay remains operated after the receiving leads are checked, causing the marker to set up the reorder indication in the incoming trunk, without completing the call to a line link frame. The reorder indication is the same as the overflow indication. On a call of this type, the frame registration is recorded in the marker as in regular operation. Numerical register relays may or may not remain operated after the check of the receiving leads, depending upon how far the call advanced in the sender before trouble was encountered. Numerical register relays, however, if operated on a call of this type, have no effect.

When the CK-3 relay releases with the RO relay operated the OF relay operates, followed by the operation of the TC and OFB relays and battery is connected to the B lead to the incoming link and connector circuit.

> When the incoming link frame is connected, this battery will operate a primary select magnet. This operation is necessary in order that 160 trunk incoming frames can give a class of trunk indication to the marker, which they do, by connecting ground through the primary select magnet off-normal springs to a CL punching.

Marker circuit YBA, YB, RV, RC and NK relays operate and battery is connected to the ST lead to the incoming link and connector circuit.

> As a result, the incoming link and trunk circuits are connected as in a regular call. The operation of an LC and F relay in these circuits cause the trunk TC and RV relays to operate and lock, and a primary select magnet to operate from grounds or battery previously connected by the marker. The operations then continue as follows:

Marker circuit FS, MAN or TOL relay operates.

> This occurs as a result of either the LC relay operation on 100 trunk incoming frames or the primary magnet operation on 160 trunk incoming frames.
>
> Ground is connected to the RC, RV and TC leads to the incoming link circuit causing RC, RV and TC relay in the trunk circuit to operate and lock.

Marker circuit RC-1, RV-1 and TC-1 relays operate and the OR relay releases.

> When the OF relay operated, a path was closed to hold the OR relay operated until after the RC-1 was operated. This insures that the marker will hold until the TC, RV and RC relays of the trunk circuit have had time to operate.

Release of the OR relay causes the SRL relay to operate, the CON-1 and CON-2 then operate and in turn operate the GT-1 and GT-2. Operation of the GT-2 connects ground to the RL lead causing the sender, sender link and connector to release and in turn release the marker.

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As described for a regular call, the marker circuit SG relay is connected to the NS lead to the number group connector circuit when the L relay operates after the selection of a line.

It remains connected in this manner until the GLH relay operates, unless the P.B.X. retest feature is used, in which case this path is opened from the time the L relay releases due to the release of the first line selected until it reoperates due to selection of the second line.

The purpose of this closure is to cover an otherwise unguarded interval during which a line which tested idle to the marker and was selected may have ground connected to its sleeve lead. This is necessary because of the time relation between the lockout of the line link frame by the terminating marker and the connection of the make busy condition on an originating call, also because a line may appear in two number groups and may be selected simultaneously by two markers, and to prevent completion of a call when possible, to a manual line which tested idle but later became busy.

If, for any of the above reasons, a selected line becomes busy while the SG relay winding is connected to its sleeve lead, the SG relay operates from the make busy ground on the sleeve of the line and battery is disconnected from the ST lead to the line choice connector circuit causing it to release.

The marker circuit SGA relay operates and if the GLH-1 is operated it can lock.

This locking circuit is provided to assure a sleeve guard recycle if the SG relay should operate at the critical marker period where the NS lead may be grounded just as the GLH relay is beginning to operate. If this is not provided, the recycle is interfered with and a routing to an intercept operator takes place.

Marker circuit CH, operated L, SG, LK, HG, GLH, GLH-1 and SGA relays release and the S relay, associated with the L relay operates.

If the GLH-1 relay had been operated, the SGA is locked up until GLH-1 releases otherwise, SGA will release then the SG relay releases.

Release of the L relay as above causes the marker to function as described under "Terminal Hunting Lines - GT Loop Test Failure - 2nd Trial." When the TLT relay operates, line test for a regular call, is repeated.

If the called line is an individual line, the BB relay operates and the call progresses for an individual line busy. On a call to a terminal hunting line, another line in the group in the same or a subsequent twenty block may be selected, the circuits advancing from this point, under terminal hunting.

SUBSCRIBER LINE OVERFLOW REGISTER CIRCUIT

When it is desired to record the number of times a particular subscriber's line is busy in a given period, the traffic department, by use of a group of jacks at the traffic register cabinet, can arrange for a traffic register to be connected for any line in the office for this purpose.

Appearing at the traffic register cabinet are ten TH-0 to 9 jacks, ten H-0 to 9 jacks, ten T-0 to 9 jacks, ten U-0 to 9 jacks and an OS jack. Four short-circuit plugs are inserted into the TH, H, T and U jack corresponding to the line number to be observed. Then a short-circuit plug is inserted into the OS jack.

Whenever the terminating marker BB relay operates for a busy back condition, except on calls using the SPL relay of the special markers, the BBA relay operates in parallel. When special markers are involved, the LKO relay opens the BBA relay path. This is to avoid registration on test calls.

The BBA relay operated connects the ST and STA lead to the subscriber overflow register circuit and if a plug is in the OS jack, it causes this circuit to be selected, if not in use by another marker. The marker cut in relays BR-1 and BR-2 then operate, connecting the register leads through for recording the line number. called on the register relays in the overflow register circuit. If the registration recorded corresponds to the line number being observed upon, the traffic register is scored.

CHAPTER 8

SECTION 6

Miscellaneous Information and Features

No Test Connector	SD-25251-01
Number Checking Trunk Circuit	SD-25258-01
Number Group Connector Circuit	SD-25276-01
Terminating Marker Circuit	SD-25283-01
Incoming Trunk Circuit From OGT Test Frame	SD-25299-01
Incoming Trunk Circuit From Line MR Rack	SD-25433-01
Incoming Trunk Circuit From Local Test Desk	SD-25436-01

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SPECIAL MARKERS

Terminating markers 0 and 1 in each office are arranged for handling special calls. These include number checking calls, no-test calls from the test desk and from the verification operator, no-hunt calls from the outgoing trunk test frame for routine tests of subscribers' lines and from the message register rack for message register tests, and regular calls from the test desk which are neither no-test nor no-hunt.

On any of the above types of calls, the trunks and senders involved are arranged to record the special condition and to indicate it to the terminating marker connector. The connector consequently selects one of the special markers and notifies it that the call is a special call. This information is necessary because the special markers may also be used for regular calls.

A special call progresses through receiving the information from the sender, except that, due to the SPL lead being grounded by the connector as an indication of the special call, the following takes place at the same time that the recording relays operate.

Marker circuit SPL and SPA relays operate, the operating circuit for the L relays is opened and the start lead battery for the number group connector circuits is opened.

> The operating ground for the L relays is opened in order to block the call until the type of the special call has been indicated to the marker.

Marker circuit OFB relay operates and battery is connected to the B lead to the incoming link and connector circuit.

> As explained under "Reorder", this battery is required by 160 trunk incoming frames to operate a primary select magnet in order that a class of trunk indication can be given to the marker.

Marker circuit NCT relay operates and ground is connected to the XG lead to the number group connector circuit, in parallel.

> Ground connected to the XG lead is used, after the number group connector circuit is seized, to operate its XGA relay. This relay is used for certain number checking calls.

Marker circuit ALZ relay releases, if operated, ALZ relay releases and the ALW and AL1 relays operate.

These operations take place only if the marker allotter circuit is set for the alternate number groups of alloted terminal hunting groups. If it is set for the number groups containing the directory numbers, the allotter circuit is not affected by operation of the SPL relay and the AL-1 relay remains operated. This circuit arrangement is used to reduce marker holding time on number checking calls. It requires, however, that outward groups of lines in alloted terminal hunting groups be included in the number group containing the directory number when possible.

Marker circuit LK-0 relay operates from ground at normal contacts of the LK-0 relay of the other special marker, closed over the LK-0 and LK-1 leads.

The LK-0 lead of each of the two special markers is connected to the LK-1 lead of the other special marker. This circuit arrangement prevents the operation of either LK-0 relay if the other one is operated. Consequently only one special call at a time can be made in an office. This prevents interference between number checking and no test calls, and between two number checking calls which might be caused by having two markers testing on the same sleeves at one time. Operation of the LK-0 relay is delayed until the LK-0 relay of the other marker releases, if it should be operated at this time.

Ground is removed from the LK-0 lead to the other special marker and the start lead battery for the number group connector circuits is closed to the HN relay contacts.

This battery is opened by operation of the SPL relay to delay seizure of the number group connector in case the other special marker should be handling a special call. It is closed by operation of the LK-0 relay, permitting the call to advance, as this operation indicates that the other marker is not engaged on a special call and simultaneously prevents it from advancing if it should be seized for such a call.

The SPL relay operated connects the winding of the NT relay to the correspondingly designated lead to the incoming link and connector circuit, in preparation for the operation of this relay for no-test calls.

The above operations take place for any type of special call. As described in the following sections, the particular type of call is indicated to the marker by the trunk circuit, over one of leads NC, NT, NH and NN from the incoming link and connector circuit. Ground closed to one of these leads after seizure of the incoming frame operates the NC-1, NT, NHA or NN relay for number checking, no-test, no-hunt, or test desk calls which are neither no-test nor no-hunt, respectively.

NUMBER CHECKING CALL
INDIVIDUAL LINE

A number checking call for an individual line progresses for regular operation, except as described above for special calls, through registration, translation and seizure of a number group connector frame. A number checking call from any type of "A" switchboard causes battery to be connected to the start lead to the number checking equipment. This circuit is arranged with a marker preference and lockout circuit as described for the other frames and returns a check signal over its CK lead to the marker, operating the IK and IK-1 relays.

If a number checking trunk from toll is used, the incoming link and connector frame on which it appears is seized as in regular operation.

In either case, the call progresses as before up to operation of the TLT relay for line test, except that the test for crossed NS leads is not effective as the operating ground for the L relays is open at the SPL relay operated. For the same reason, no L relay can operate for the selection of a line and the BB relay cannot operate.

In addition, when the marker connects ground to the FC lead to the connector circuit, the number checking trunk circuit is advanced as for an incoming trunk circuit. The FC lead is closed in this case through the connector circuit, the number checking sender or the "B" sender, and the number checking link or the "B" link, to the "A" switchboard number checking trunk or the toll number checking trunk, respectively. The trunk circuit in turn connects ground to its NC lead. The NC lead from the "A" switchboard trunk is closed directly to the marker, the NC lead from the toll trunk being closed to the marker through the incoming link and connector circuit. This closure causes the marker NC-1 relay to operate, this disconnects the operating for the LC, CA and CB relays.

> This battery is disconnected to prevent seizure of the line choice connector circuit if the L relay should operate as described later on a failure to check.

Marker circuit NCD and NC-2 to NC-5 relays operate.

> Any S relays that may have operated releases at this time.

Marker circuit NC-6 to NC-14, relays operate and alternating current, 135 cycle, is connected through an NC resistance and an NC condenser to the NS lead corresponding to the called line.

The 135 cycle alternating current connected to the NS lead is closed through the number group connector circuit to the sleeve lead of the line, through the sleeve contacts of the primary and secondary line link switches, sleeve of the district junctor used for the call being checked, sleeve lead through the district and office primary and secondary switches to the sleeve of the special service trunk circuit or the subscriber's recording completing trunk circuit. If the "A" switchboard operator is checking the line, the path is completed from the sleeve of the special service trunk circuit to the operator's cord circuit and through the position circuits to the number checking equipment in use, to the CTL lead to the marker. If the checking call was made by the toll operator, the tone is closed from the subscriber's recording completing trunk circuit through a sleeve signal repeating circuit to the number checking trunk in use, and then through the incoming link and connector circuit to the CTT lead to the marker. The CTL and CTT leads connect through the winding of the marker NC relay to ground.

The NC relay is a telegraph relay arranged to operate in the above path, provided that the correct number was given by the subscriber. If a wrong calling number was given, the path is open between the NS lead corresponding to the number being checked and the sleeve lead of the line actually used for the originating call.

When the NC-14 relay operates, closing the 135 cycle alternating current as above, it also opens the operating circuit of the slow release NCT relay. This relay is sufficiently slow to allow time for the check to be completed. It performs no function if the check is satisfactory, being used to advance the circuits as described if the NC relay does not operate.

If a satisfactory check is made then the marker NC and NCA relays operate.

The NCA relay is slightly slow operate to compensate for false momentary operation of the NC relay due to surges.

Marker circuit OK, RC, RC-1, RV and RV-1 relays operate and ground is connected to the RC and RV leads to the number checking trunk circuit and the incoming link and connector circuit.

Ground connected to the RC and RV leads is closed to the "A" switchboard number checking trunk or through the incoming link and connector circuit to the toll number checking trunk or to the number checking sender causing the operation of corresponding relays. These relays cause a number checking lamp at the operator's position to light steadily as an indication of a satisfactory check and extend their locking grounds to the marker, holding the RC-1 and RV-1 relays.

Marker circuit OR relay releases and the SRL relay operates.

From this point the call proceeds as described for an individual line busy, except that the operating path of the GT-1 and GT-2 relays is traced from battery through their windings in parallel, normal contacts of the X relay, through operated contacts of the SPL and CCN-2 relays to ground. The release of the BB, TC and TC-1 relays is omitted. The OK relay and the NC-6 to 9 relays release when the CK-6 relay releases. The SPL relay releases when the connector circuit removes ground from the SPL lead. It in turn releases the LK-0 relay. Release of the recording relays causes the check path to be opened, releasing the NC relay. This in turn releases the NCA relay. When the trunk circuit opens the NC lead, the NC-1 relay releases, in turn releasing the NCD, NC-10 to 13 and NC-14 relays and the NC-2 to 5 relays.

If the NC relay does not operate when the 135 cycle current is connected, release of the NCT relay given below causes the circuit to advance as follows for indicating failure to check, the NCT relay is slow release to allow time for the return of the check signal.

Marker circuit NCT relay releases and the NCC relay operates, the 135 cycle alternating current is disconnected from the NS lead corresponding to the called line.

Marker circuit NC-10 to NC-13 relays release and the NC-15 and NC-16 relays operate followed by the operation of the L relay corresponding to the called line.

Operation of the L relay causes relays LE-1 to LE-12 to release and function as described for a regular call. It does not cause the selection of a line choice connector circuit, however, or advance the marker for recording a quarter-choice and horizontal group indication, as the operating battery for the LC, CA and CB relays is open at the NC-1 relay operated. The NC-10 to NC-13 relays are released as above in order to remove the NC condensers from the circuit so that these condensers will not interfere with the operating circuit for the L relay. The NC-0 to NC-13 resistances are provided in case of bunching at the NCC relay contacts to prevent damage to these contacts and to prevent overloading the 135 cycle power supply.

Marker circuit NCD relay releases.

The NCD relay is slow release to allow time for operation of the L relay as above. This, however, performs no function on a call to an individual line. It is used in a number checking call involving jump hunting, as described, in which case the L relay for the line wired for jump hunting is required to ground the NF and NC leads to provide the jump hunt, these leads in this case being cross-connected to leads JF and JC.

Marker circuit NCF, RV and RV-1 relays operate and ground is connected to the number checking trunk circuit and to the incoming link and connector circuit.

Ground connected to the RV lead is closed to the "A" switchboard number checking trunk or through the incoming link and connector circuit to the toll number checking trunk or to the number checking sender, causing the operation of a corresponding relay. This relay causes a number checking lamp at the operator's position to flash as an indication of a number check failure and extends its locking ground to the marker, holding the RV-1 relay.

Marker circuit OR relay releases and the SRL relay operates.

From this point the marker returns to normal as described for a satisfactory check except that the release of the RC, RC-1, OK, NC, NCA, NCD and NC-10 to 13 relays is omitted. The NCC and NCF relays and the operated L relay release when the CK-7 relay releases. Release of the NCC relay causes the NC-15 and NC-16 relays to release.

If a reorder signal is received in connection with a number checking trunk, the trunk is not set for overflow, a number check failure signal being returned as described.

NUMBER CHECKING CALL
TERMINAL HUNTING LINE

On a number checking call to the directory number of a terminal hunting group, all lines of the group are checked if necessary so that the check signal can be returned for any line in the group that may have been used for the originating call.

If the terminal hunting group is included within a twenty block, the operation for a number checking call is as described in a previous section, except that the 135 cycle alternating current is connected simultaneously to the NS leads corresponding to all of the lines of the group, due to the HT relays for all except the last line being operated. Consequently the line used for the originating call returns the check signal, whatever line in the group it may be. If a wrong calling number is given the path to operate the NC relay is open between the NS leads corresponding to the group of terminal hunting lines and the S lead of the lines used for the originating call.

Also due to the HT relays being operated, the L relay corresponding to the last line of the group operates on a number check failure.

NUMBER CHECKING CALL
END OF BLOCK HUNTING

A number checking call to the directory number of a terminal hunting group arranged for consecutive or non-consecutive end of block hunting progresses up to closure of the 135 cycle alternating current. This current is connected to the NS leads corresponding to all of the lines of the group in the twenty block containing the directory number and is closed simultaneously through HT-19 operated and rectified by the C varistor, operating NCB. This takes place upon the operation of NC-14 at the same time that the path for slow release relay NCT is opened.

If the call being checked was originated on one of the lines of the group in the twenty block containing the directory number, operation of NCB performs no function and a satisfactory check signal is returned.

If the call was originated on some other line, however, and the NCA and OK relays are normal when the NCT releases the marker PG-1 and PG relays operate.

An odd number HP relay, numbered one higher than the HP relay that is up, operates and locks and the UT relay operates. The TB relay in the number group connector and the TBW in the marker release.

The marker HT, TBK, NC-10 to NC-14, NCB, PG-1 and PG relays release and the NCT relay operates.

The next higher even numbered HP relay operates and locks and the TB relay in the number group connector numbered one higher than the TB relay originally used and the marker TBW and TBK relays operate.

The marker HT relays corresponding to terminal hunting lines in the selected twenty block operate.

Marker circuit NC-10 to NC-14 relays operate.

> With the above operations completed, the circuit is reset for number checking on the lines in the terminal hunting group in the second twenty block. Operation of the NC-14 relay causes the 135 cycle alternating current to be connected as before to the sleeve leads of the lines involved and it opens the path of the slow release NCT relay. If the terminal hunting group is arranged for another end of block hunt, the NCB relay reoperates at this time due to the HT-19 relay being operated.
>
> The UT relay operated causes number checking to start at the first line of the twenty block, as described for line test in a terminal hunting call of this type.
>
> From this point the circuit advances for the return of a satisfactory check signal or a number check failure signal. If the group is arranged for additional and of block hunts, the successive twenty blocks are checked as described above. The last twenty block in the group is indicated to the marker by the HT-19 relay or a lower numbered HT relay, whichever corresponds to the last line of the group, remaining normal. This prevents operation of the NCB relay and causes a number check failure signal to be returned if the marker hunts to this point without closing the sleeve leads for operating the NC relay.

NUMBER CHECKING CALL
ALLOTTED TERMINAL HUNTING GROUP

Outward lines in allotted terminal hunting groups are included, as far as possible, in the number group containing the directory number, and the allotter circuit is set for this number group on all special calls. This arrangement reduces the number of times that the marker must release one number group and select the other on number checking calls.

If, however, all the lines of such a group connected due to the AL-1 relay being operated should be number checked without operating the NC relay, the setting of the allotter circuit is changed and the lines in the alternate number group are connected.

On a number checking call made to the directory number of a group of this type, the lines in the number group containing the directory number are checked as described, end of block hunting taking place if necessary. However, due to the AL cross-connection from the SH relay, the allotter circuit is prepared to release these lines and connect those of the alternate number group as described for a regular terminal hunting call to an allotted group. This includes operation of the AL, NFL or FL, HPE and UT relays. With the UT relays operated, number checking starts at the first line of the first twenty block seized, as described for line test under similar conditions.

If the line used for the originating call is found in the number group containing the directory number, a satisfactory check signal is returned. If the line is not found in the first number group, however, the following takes place after the last twenty block associated with these lines is checked.

Marker circuit NCC relay operates and the 135 cycle alternating current is disconnected from the NS leads.

Marker circuit NC-10 to NC-13 relays release, NC-15 and NC-16 relays and the L relay corresponding to the last line of the P.B.X. group operate.

> Operation of the L relay at this point is incidental and performs no useful function. It does not cause the selection of a line choice for reasons given.

Marker circuit NCD relay releases and the ALA relay operates and locks.

> Due to operation of the ALA relay, the allotter circuit advances, releasing the number group and incoming link originally selected and seizing the alternate number group under terminal hunting. During this process release of the TB relay in the number group connector circuit causes the marker circuit HT relays to release, in turn releasing the L relay. Release of the TBK relay releases the NC-14 15 and 16 relays. The NC-14 relay in releasing releases the NCC relay and operates the NCT relay. Upon release of the NCC relay, the NCD relay reoperates.

Release of the incoming link, releases the NC-1 relay in turn releasing the NC-2 to 9 and NCD relays.

When the allotter circuit has advanced and seized the other number group, operation of the NK relay causes the incoming link circuit to be reseized. The incoming link causes the NC-1 relay to operate, operating in turn the NC-2 to 9 and NCD relays, the NC-10 to 13 operate if the TBK has operated by this time and NC-14 follows their operation. The lines in the alternate number group associated with the terminal hunting group are then number checked as described, end of block hunting taking place if necessary.

If the check signal is not returned on any of these lines, the NCC relay reoperates after the last twenty block is checked, functioning as above. Upon the release of the NCD relay, however, with the AL and ALB relays operated, the NCF relay operates causing a number check failure signal to be returned.

NUMBER CHECKING CALL
JUMP HUNTING

A number checking call to a terminal hunting group arranged for jump hunting progresses for a complete call if a satisfactory check is obtained on any line preceding the terminal cross-connected for jump hunting. End of block hunting may take place if the group is so arranged.

However, if none of these lines return the check signal, the NCC relay operates upon release of the NCT relay when the twenty block including the terminal wired for jump hunting is checked. The NCC relay operated functions as described for a number check failure on an individual line, providing a holding path for the NC-14 relay and releasing the NC-10 to 13 and NCD relays. The NC-15 and 16 relays operate, in turn causing the L relay corresponding to the terminal wired for jump hunting to operate and lock. This may be any one of the 20 L relays.

Operation of the L relay connects ground to the corresponding NF and NC leads, which are cross-connected in this case to the JF and JC punchings which correspond to the twenty block and start point for the jump hunted lines.

Operation of the L relay consequently causes jump hunting to take place as for a regular terminal hunting call up to release of the TBK relay which in turn releases the NC-14, 15 and 16 relays. The NC-14 relay in releasing releases the NCC relay and operates the NCT relay. When the NCC relay releases, the JHB and NCD relays operate in parallel. Operation of the JHB relay causes the circuit to advance for jump hunting, except that line test on the jump hunted lines is not made.

Reoperation of the TBK relay due to the above causes relays NC-10 to NC-13 to reoperate, followed by NC-14. Operation of the NC-14 relay connects the 135 cycle alternating current and opens the path of the slow release NCT relay. Consequently the jump hunted lines are number checked, the circuit advancing as before for the return of a check or failure signal.

The path to operate the NCF relay is opened by operation of one of relays JF-0 to 4 and until the JHB relay operates to prevent false return of a number check failure signal due to momentary release of the NCD relay.

XF CROSS-CONNECTING FIELD - OS 528

RF, HF and TF-0 to 19 terminals are provided on the block relay frame for cross-connection from NF terminals to indicate class of line and line choice. In addition, the block relay frame includes an XF cross-connecting field which is used when it is desired to number check consecutive lines not included in the incoming service group.

The XF cross-connecting field consists of terminals XF-0 to XF-19 arranged for cross-connection from NF terminals as described for the RF, HF and TF terminals. These terminals are wired to armatures on the XGA, XG-1, XG-2 and XG-3 relays of the number group connector circuits. The associated normal contacts are wired, respectively to leads RF-0 to 19 and the operated contacts are wired to leads HF-0 to 19. Consequently with the XG relays normal a cross-connection made to an XF terminal indicates to the marker that the line is to be treated as a direct line or the last line of a terminal hunting group and with the XG relays operated a hunt line indication is provided. The numerical designation of the XF terminal selected indicates the line choice, as described for the other terminals.

The XGA relay in the number group connector circuit is operated on number check and no-test calls, from ground at operated contacts of the marker circuit SPL relay closed to the XG lead. The XGA relay, operates the XG-1, XG-2 and XG-3 relays. Consequently the marker can hunt past lines having XF cross-connections on numbers checking calls but is prevented from doing so on regular terminating traffic as for such calls the XG relays are normal.

The NF terminal of the last line of a terminal hunting group is cross-connected to an XF terminal when there are additional consecutive lines which are to be combined with the group for number checking, but not for regular terminating traffic.

If the lines to be combined as above appear in hunting sequence on a twenty block relay no other special arrangements are required for this purpose, as on a number checking call with the XGA, XG-1, XG-2 and XG-3 relays operated, they are temporarily treated as one group. The same condition applies if the lines are to be arranged in hunting sequence on two or more twenty block relays by means of end of block hunting or jump hunting. When end of block hunting is used the last terminal of a twenty block, is cross-connected to an XF terminal. When jump hunting is used, the terminal preceding the one wired for jump hunting is cross-connected in this manner. By means of bridged sleeve cross-connections with coded lines and the jump hunting feature any lines in the office may be added to a terminal hunting group for number checking.

Ground connected to the XG lead on special calls, in addition to operating the XGA relay in the number group connector circuit, is also closed to the CT lead to the traffic register circuit.

NO-TEST AND NO-HUNT CALLS

NO-TEST CALL OS 524, SC 504

No-test calls originate at verification positions of the "A" board or at the test desk. If the called line is idle, the connection is established over the regular channel, namely the incoming and line link frames. However, if the called line is busy the connection is established over the "no-test train" consisting of a no-test connector hold magnet and a line link no-test hold magnet.

On each line link frame, the first hold magnet of each horizontal group is reserved for the completion of no-test calls. These hold magnets are commonly referred to as no-test verticals. The T, R, S and H leads of the no-test verticals of the first five horizontal groups (0 to 4) are multipled and the NT leads of the associated HG relays are connected in the same manner. The five remaining no-test verticals and the NT leads of their associated HG relays are also connected in multiple. This forms two groups of T, R, S, H and NT leads from each line link frame to its associated no-test connector switch.

There is a 100 point crossbar switch, known as a no-test connector switch associated with each line choice connector circuit and located on the miscellaneous bay. There is one line choice connector circuit for each line choice, consisting of four line link frames. Therefore, the no-test connector switch associated with the line choice connector circuit has access to the four line link frames within the line choice. The no-test trunk circuits appear as horizontals on the no-test connector switch and usually appear on the same horizontal of all such switches. The T, R, S and H leads associated with the 0 hold magnet of the no-test connector switch are wired to similarly designated leads of the five no-test verticals of horizontal groups 0 to 4 of the first line link frame in the line choice. The NT lead from the winding of the 0 hold magnet is connected to the commonly formed NT lead associated with the HG-0 to 4 relays of the same line link frame. The leads associated with the 1 hold magnet of the no-test connector switch are connected to the T, R, S, H and NT leads formed by the five no-test verticals and HG relays for horizontal groups 5 to 9 of the same line link frame. The remaining hold magnets of the no-test connector switch are connected in the same manner, that is two hold magnets to each remaining line link frame in the line choice. In this manner only 8 hold magnets of each no-test connector switch are used, the two unused hold magnets being reserved as spares.

When the marker connector circuit seizes the marker on a no-test or any special call, the SPL relay operates. The marker proceeds as in a regular call and when the F relays of the no-test trunk operate, they operate a select magnet associated with the trunk on each no-test connector switch and connect ground to the NT lead, causing the marker NT relay to operate and ground is connected to the secondary winding of the LF-0 to LF-9 relays.

> The secondary windings of the LF relays are used to bias the relays so that they will not operate on a difference in frame ground potential.

The operating circuit of the BB and UT relays is opened.

> If the UT relay is operated, as in a call to a line in an allotted PBX, it releases at this time because on a no-test call line test must start at the called number, and not at the first line of the associated twenty block.

The operating circuit of the LE-1 and LE-2 relays is opened.

> By preventing the LE-1 and LE-2 relays from operating, the operating paths of the HT-0 to 19 relays are opened thereby preventing terminal hunting from taking place and making all lines appear as individual lines.

Marker circuit NT-1 relay operates.

> The NT-1 relay operates if the UT relay is normal or in the case of an allotted PBX when it releases. The NT-1 relay is slow operate so as to insure that the UT relay is fully released.

Marker circuit NTH, NTR and LE relays operate.

> The LE relay operates provided that the NT and the LE-3 to LE-6, LE-8 to LE-11 relays are operated.

Marker circuit TLT relay and L relay corresponding to the location of the called number in the twenty block operate.

> The L relay to operate is determined by the units registration and whichever of relays TEV and TOD are operated. It operates at this time only if the NT-1 relay is operated and if the called line is idle, as indicated by the corresponding S relay being normal.
>
> If the L relay operates at this time due to the line being idle the marker establishes the connection as described for a regular call. Under this condition, the SPL relay being operated causes the operation of the CON-1 and CON-2 relays when the marker circuit SL-1 relay operates. The operation of the CON-2 relay with the SPL relay operated causes the operation of the GT-1 and GT-2 relays. Therefore, on a no-test call line

continuity test and the check of the ringing control relays are omitted. In addition, the false charge, ground and plugging-up cord tests are ineffective as the TT and RT leads are open in the test trunk.

When the TLT relay operates, if the S relay associated with the called line is operated, the marker circuit NTT relay operates and locks.

Marker circuit LFA, LFB and the NC-2 to NC-5 relays operate and the S relay corresponding to the location of the called number in the twenty block releases.

The operation of the NC-2 to 5 relays opens the operating path of S relays 0 to 19, thereby releasing the S relay associated with the called number.

A marker circuit L relay corresponding to the location of the called number in the twenty block, operates and locks and twenty four to twenty eight volt positive battery through 28 ohms resistance is connected to the NS lead associated with the called number.

From this point the marker proceeds as described for a regular call, up to the operation of the HG relay of the horizontal group of the line link frame on which the called line is located. If, at the time the HG relay operates, the no-test connector associated with the particular horizontal group is busy, there is ground on the NT lead which is connected to the marker causing the marker circuit JB relay to operate and lock.

Marker circuit OF relay operates and locks.

The call proceeds from this point as described for overflow. This is an indication that the marker cannot connect to the line because the no-test train is busy. However, if when the line link HG relay operates, the no-test train is idle.

A marker circuit LF relay operates.

There are ten LF relays, designated 0 to 9, the primary windings of which are applied by the operation of the HG relay to the sleeves of the 10 line links having access to the called line. The positive battery potential previously connected to the NS lead of the called line is extended through the crosspoints of the operated line hold magnet to the sleeve of the line link that is holding the line busy. Therefore, the ten line links are tested, by the polarized LF relays, for the positive battery potential and the LF relay to operate is the one associated with the line link meeting this condition. It is due to this method of identifying the line link involved on a busy condition that makes it necessary to employ a 10 ohm resistance ground in the district junctor or incoming trunk, as a service busy condition throughout the crossbar system, as a solid or lower resistance ground would shunt the positive potential and thereby defeat the purpose of this test.

A marker circuit CH relay operates and locks.

> The numerical designation of the CH relay to operate corresponds to the designation of the operated LF relay. The regular path for operating a CH relay (during selection of a channel) is opened at the contacts of the operated NTT relay.

Marker circuit TE and NTH relays release. The line link primary and secondary select magnets associated with the line link that is holding the called line operate.

> The NTH relay is slow release to allow time for the line link primary select magnet to operate.

Ground is connected to the NT lead to the line choice connector circuit.

> The ground on the NT lead is extended through the line choice connector circuit to the operated line link and control circuit HG relay, to the NT lead to the no-test connector switch, thereby operating the proper no-test connector hold magnet. This causes a crosspoint closure at the level of the operated select magnet on the no-test connector switch. With the no-test connector hold magnet operated, the operating ground is extended through the make contacts of the H hold magnet to the H lead to line link frame.

Five no-test hold magnets of the line link frame operate and the crosspoints are closed at the level of the operated primary select magnet.

> Even though five no-test hold magnets operate, only one set of crosspoints is closed as the only primary select magnet operated is the one associated with the busy link within the horizontal group. At this time the no-test trunk is connected through the no-test connector switch and no-test and no-test vertical to the busy line link and thence to the called line. Since the connection is made to a busy line, 10 ohm resistance ground is present on the sleeve of the line link. This ground is extended through the crosspoints of the no-test vertical and the no-test connector switch to the no-test trunk where it operates a relay. The operation of the trunk circuit relay connects ground to the H lead thereby holding the no-test connector switch hold magnet and the five operated line link no-test hold magnets.

Marker circuit NTR relay releases.

> The NTR relay is slow release to allow time for the operation of the hold magnets and the operation of the no-test trunk holding relay.

Ground is connected to the RL lead to the terminating marker connector circuit.

The ground on the RL lead causes the sender circuit to disconnect from the connector circuit thereby effecting the release of the connector, which in turn releases the CK-6 and CK-7 relays of the terminating marker. From this point disconnection occurs as for a regular call except that the trunk circuit F relay is released as a result of the sender circuit releasing the sender link hold magnets. In addition, the following releases occur: The marker NT relay releases when the incoming F relay releases. The release of the NT relay releases the NT-1 relay. The operated L and NTT relays release when the CK-7 relay releases, the NTT relay in turn causing the release of the LFA, LFB and NC-2 to 5 relays. The operated LF relay is released when the LFA and LFB relays release and the operated CH relay releases when the number group connector circuit releases the NK relay. The operated line link select magnets are released due to the release of the CH relay.

LINE BUSY BUT MARKER UNABLE TO CONNECT - SC 504

In some cases none of the LF-0 to 9 relays will operate. This may be due to a trouble ground on the sleeve of the line link, a make busy ground applied to the sleeve by means of a key in some special line circuits, or because the connection which is holding the line busy is established manually through the "A" board instead of through the switches or that a make busy cord is connected to the sleeve at the LDF.

In the event that none of the LF relays operate, the call proceeds as described for a regular call. When the TKT relay operates while the TE relay is still operated, the NTB relay operates and the NCT relay releases.

The NCT relay is slow release to allow sufficient time for a CH relay to operate (as a result of an LF-0 to 9 relay operating) and release the TE relay before allowing the circuit to continue. If the TE relay has not released by this time, the following takes place.

Marker circuit BB relay operates and locks. (NCT release)

The marker and associated circuits advance from this point as described for individual line busy. For a no-test call to an allotted terminal hunting group the operation of the SPL relay sets the allotter on the "A" group and any change to the "B" group is prevented. Whether the called number is in the "A" or "B" allotment makes no difference because it will be selected in its regular numerical sequence and not on the basis of the PBX allotter.

On no-test calls end of block hunting either consecutive or non-consecutive, does not take place because only one twenty block relay is used, due to the desired line number being indicated by the tester.

> Jump hunting can take place on a no-test call if a terminal wired for jump hunting is called. In this case it tests idle and the marker jump-hunts to its appearance on the jump hunt block, after which the no-test call is completed.

NO-HUNT CALL

No hunt calls originate at the outgoing trunk test frame for routine tests of subscribers' lines, or at the message register rack. They are the same as regular calls except that terminal hunting and certain marker tests are omitted.

When the marker connector circuit seizes the marker on a no hunt or any special call, the SPL relay operates and performs the functions described. The marker proceeds as in a regular call and when it operates the F relay of the trunk circuit, it in turn connects ground to the NH lead to the marker circuit causing the NHA relay to operate.

Marker circuit SPA relay releases, NH relay operates and the operating circuit of the UT relay is opened.

> If the UT relay is operated, as in a call to a line in an allotted PBX, it releases at this time because on no-hunt calls, line test must start at the called number and not at the first line of the associated twenty block.

The operating circuit of the LE-1 and LE-2 relays is opened.

> By preventing the operation of the LE-1 and LE-2 relays the operating paths of the HT-0 to 19 relays are opened, thereby preventing terminal hunting from taking place and making all lines appear as individual lines.

Marker circuit NT-1 and LE relays operate.

> The LE relay operates as the result of the NH and the LE-3 to LE-6, LE-8 to LE-11 relays being operated.

Marker circuit TLT and L relays operate. The L relay corresponds to the location of the called number in the twenty block.

> The L relay to operate is determined by the units registration and whichever of relays TEV and TOD are operated. It operates at this time if the NT-1 relay is operated and if the called line is idle, as indicated by the corresponding S relay being normal.

Under this condition the marker proceeds to establish the connection as described for a regular call. If the marker is establishing the call to the first or an intermediate line of a terminal hunting group the HF relay operates and connects ground to the HF lead to the incoming link and connector circuit. This lead is only effective in the trunk from the message register rack where it results in the lighting of a lamp to indicate a terminal hunting line. On this type of call when the marker circuit SL-1 relay operates with the SPL relay operated, the CON-1, CON-2 relays operate. The operation of the CON-2 relay, with the SPL relay operated, operates the GT-1 and GT-2 relays. Therefore, on a no-hunt call, line continuity test and the check of the ringing control relays are omitted. In addition the false charge, ground and plugging up cord tests are ineffective as the TT and RT leads are open in the test trunk. The marker circuit releases as described for a regular call, and when it releases the incoming trunk F relay, it in turn releases the marker NH relay which causes the release of the NT-1 relay.

If at the time the TLT relay operates the S relay associated with the location of the called line in the twenty block is operated, the marker circuit BB relay operates and locks.

From this point the marker advances and disconnects as described for individual line busy. On no-hunt calls, lines wired for allotted PBX, end of block hunt and jump hunting are cared for as described under no-test calls.

TEST DESK CALLS WHICH ARE NEITHER NO-TEST NOR NO-HUNT - SC 504

These calls originate at the test desk over regular trunks which are neither no-test nor no-hunt and require the service of a special marker in order to cancel certain tests and thereby prevent the engaging of the trouble indicator due to certain types of line troubles that might be encountered by a test desk call.

The marker is seized for service in the usual manner and the SPL relay is operated, functioning. The call proceeds as a regular call, the marker operating the trunk circuit F relay which in turn causes the operation of the marker circuit NN relay by grounding the NN lead to the marker. The NN relay then operates and in turn releases the SPA relay, followed by the operation of the NT1 relay. On calls of this type, line continuity test is cancelled when the SL-1 relay operates, causing the operation of the CON-1 and CON-2 relays due to the SPL relay being operated. The operation of the CON-2 relay on a special call cancels the check of the ringing control relays by operating the GT-1 and GT-2 relays.

In addition to the above, the false charge, ground and plugging up cord tests are ineffective as the TT and RT leads are open at the trunk circuit. The marker is released as described for a regular call, the SPL relay releasing upon the release of the connector circuit and the NN and NT-1 relays releasing after the trunk circuit F relay releases.

CHAPTER 8

SECTION 7

Miscellaneous Information and Features

Incoming Link and Connector Circuit 100 Trunk Capacity	SD-25032-01
Terminating Marker Connector Circuit	SD-25036-01
Line Choice Connector Circuit	SD-25275-01
Number Group Connector Circuit	SD-25276-01
Terminating Marker Circuit	SD-25283-01
Incoming Link Connector Circuit 160 Trunk Capacity	SD-25457-01
Line Link and Connector Circuit	SD-25553-01

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INTERCEPT CALLS

Numbers may be left blank in blocks of 500, blocks of 100 or individually. In each case corresponding equipment or cross-connections or both may be omitted and the call is ultimately routed to the intercepting operator by means of intercept trunks.

To reach intercept trunks, internal marker punching cross-connections are made for the purpose of indicating to the marker where the regular, toll or trouble intercept trunks are located on the line link frame verticals.

Associated with the operated contacts of the LIN, TIN, LTI and TTI relays, are the ST, L, HB and TB punchings in Figs. C and H. There are four groups of these punchings between Fig. C and H, one for local intercept, toll intercept, local trouble intercept and toll trouble intercept.

For each of these groups of punchings, the ST and HB are cross-connected to the NG-ST and NG-HB punchings in Fig. 7, in order to gain access to the number group and its HB relay corresponding to the location of the intercept trunks. The TB punching is cross-connected to the desired TB punching in Fig. 11 in order to gain access to the proper 20-block relay. The L punching is cross-connected to an L-punching in Fig. 10 in order to start testing at the first intercept line of the group, within the 20-block.

REGULAR INTERCEPT

INDIVIDUAL LINES UNEQUIPPED - SC 503, OS 523

When a line is permanently disconnected from service the MDF, LDF and block relay frame NF and NC cross-connections are removed. The fact that there are no NF and NC cross-connections for a particular directory numbered line, indicates to the marker that the line is intercepted.

Both the NF and NC cross-connections must be placed for a working line or removed for an intercepted line. If either an NF or NC cross-connection is in while the other is out, an intercept routing is blocked and the marker will time out. The marker proceeds with the call in the regular manner up to an including the operation of an L relay to select the called line. In this case, since there is neither an NF or NC cross-connection installed, no LLGA to LLGD relay. RF, TF or HF relay will operate.

When the LE-7 relay has released the marker circuit INA relay releases.

> The INA relay is slow release to allow sufficient time for an LLGA to D and an RF, TF or HF relay to operate on regular calls, to prevent intercepting a call falsely.

Marker circuit INC relay operates.

> Battery is connected to the B lead to the incoming link and connector circuit.

Incoming link and connector circuit primary select magnet for the calling trunk operates and the marker circuit FS, MAN or TOL relay operates.

When only 100 trunk incoming link frames are associated with the central office, the FS, MAN or TOL relay is operated when the incoming link frame LC relay operates.

The FS, MAN or TOL relay indicate the class of incoming trunk. The operation of any one of these relays does not affect a regular call in any manner other than a call to a free line. However, on calls to intercepted numbers it is necessary to differentiate, because there are two groups of trunks to the intercepting operators for regular intercepting, namely local and toll, the route relays for which are designated LIN and TIN respectively. The marker routes all intercepted calls from full selector and manual incoming trunks to the local intercept trunk group and all intercepted calls from incoming toll trunks to the toll intercept trunk group. The intercepting trunks are separated in this way in order to permit the intercepting operator to recognize and handle toll intercept calls in a different and preferred manner in order to reduce the holding time on toll incoming trunks.

Marker circuit LIN or TIN relay operates and locks.

The release of the INA and the operation of the INC relays with the TF, RF, HF and the LLGA to LLGD relays normal causes the operation of the LIN or TIN relay depending upon the class of trunk calling.

Marker circuit IN relay operates and the FH-relay releases, followed by the release of the MP-relay in the number group connector circuit.

This causes the complete disconnection of the number group connector circuit.

When the number group HB- relay releases it causes the release of the marker circuit TBW and TBK relays. Release of the TBW relay releases the TLT relay in preparation for testing the intercepting trunks.

Marker circuit NK and NK-1 relays release followed by release of incoming link and connector circuit MP- relay.

This causes the complete disconnection of the incoming link and connector circuit.

Marker circuit IK and IK-1 relays release and ground is removed from the FC lead to the terminating marker connector circuit.

This causes the release of the trunk circuit F relay in order to prevent double connections should another marker seize the incoming link and connector circuit at this time.

Marker circuit FS, MAN or TOL relay releases and the SIN relay operates and locks.

The SIN relay operates over a path through the normal contacts of the LK, NK and IK relays. Operation of the SIN relay makes effective the intercept cross-connections, therefore, the call continues from this point as described for a regular call. On intercepted calls, the operation of the SIN relay causes the operation of the GT- 1 and GT- 2 relays when line continuity test is satisfactory completed, thereby cancelling the check of ringing control relays. Disconnection occurs as for a regular call, the SIN relay releasing when the CK-5 relay releases and the LIN or TIN relay being released upon the release of the CK-6 and CK-7 relays and in turn releasing the IN relay.

When the intercept operator answers, the incoming trunk S relay remains normal preventing the CS relay in the crossbar district junctor or the panel district selector from operating and setting up a charge condition.

Intercepting trunks originate at primary verticals on the line link frames.

UNEQUIPPED NUMBERS SC 503, OS 523

When a block of 500 numbers is omitted, the corresponding relays for that block in the number group connector circuit and in the marker need not be furnished. When a 500 block is not equipped, the corresponding marker BN terminal of Fig. C is cross-connected to the B terminal of Fig. AF.

When a five hundreds block relay (FH) is equipped but one or more of its hundreds blocks of numbers are blank, the corresponding "HB" terminals of Fig. 3 are cross-connected to the B terminal of Fig. AF. The corresponding ST punching is not cross-connected.

When a marker is seized for a call to a line within the blank 500 or 100 block, it proceeds as described for a regular call up to and including the operation of the marker recording relays. The ground, which otherwise operates an FH- relay or grounds the HB lead to the number group connector circuit, causes the marker circuit BLK to operate and the number group connector circuit MP- relay to operate and lock.

Operation of the BLK relay connects battery to the ST lead to the number group connector circuit in which the local intercept trunks have their terminals. From this point the marker proceeds as described for a regular call to the operation of the LF relay. However, during this interval no twenty block relay is operated since none are supplied in the number group connector circuit for a 500 or 100 block of unequipped numbers. Therefore, the TLT relay cannot operate for line test because its secondary winding is energized by the normal TBW relay.

Marker circuit OFB relay operates.

The operation of the OFB relay provides for the marker to advance and operate the FS, MAN or TOL relay, without the aid of the LK relay, when a 160 trunk incoming link frame is being used. Upon the operation of the OFB relay the circuit advances to connect the call to an intercept trunk.

Under this condition, when the IN relay operates, the FH- relay releases if one has been operated. In addition, the operation of the IN relay or the release of the FH relay causes the release of the BLK relay, which in turn releases the OFB relay.

DENIES SERVICE LINES - FULL DENIAL - SC 503, OS 523

To deny service to lines, the S and M cross-connections are removed at the V.L.D.F. In this case due to the S lead being open the call is routed to intercept. On calls of this type the marker proceeds as described for a regular call, up to and including the operation of the GLH relay. Due to the open S lead a line hold magnet cannot operate and when the TLH relay releases, it effects the release of the marker circuit HG relay which in turn operates the LIN or TIN relay. The operation of either of these relays causes the marker to proceed as described for an unequipped individual line except, that the release of the LK-1 relay will cause the line choice circuit to be disconnected and the operation of the SIN relay will be delayed until the LK relay has released. All hold magnets that have been operated will release when the CH relay releases following the release of the NK relay.

SPECIAL CALLS FOR UNEQUIPPED OR DENIED LINES SC 503

As described, special calls consist of number checking, no-test, no-hunt and neither no-hunt nor no-test calls. Any of these types of calls to unequipped or denied lines cause minor differences in operation in the special markers.

NUMBER CHECKING CALL

On calls of this type the SPL and NC-1 relays in the marker are operated. With the SPL relay operated, if the call is for a blank 500 or 100 block, the LIN or TIN relay cannot operate. The BLK relay in operating causes the operation of the NCF relay. From this point the marker proceeds as described for a number checking failure.

If the call is for an individual unequipped line (NF and NC cross-connections removed) the LIN or TIN relay cannot operate, because the INC relay cannot operate, and the call proceeds as described for a number checking call. However in this case or if the line is denied service, the S lead of the line cross-connection on the V.L.D.F. is open, thereby preventing a closure of the 135 cycle current to the sleeve of the line, and the call proceeds as described for a number checking failure.

NO-TEST, NO-HUNT AND NEITHER NO-HUNT FOR NO-TEST CALLS

For calls of this type the marker SPL relay and the NT or NH and the NN relays are operated. The SPL relay opens the operating path of the LIN and TIN relays until such time that the NT-1 relay operates and recloses it, on calls to an unequipped 500 or 100 block. The circuit for operating the intercept route relays in the event of an open NF and NC, or S lead is not affected.

In either of the above cases, the operation of the LIN or TIN relay causes the release of the SPL relay which in turn, releases the NH or NT relay. These special relays are released in order to permit the marker to terminal hunt when the group of intercepting trunks is connected.

In both special markers whether the call is special or not, the operation of the IN relay, on a call to intercept, operates the CCT relay. When the TLH relay releases, after setting up the channel to the intercepting trunk, the CON-1, and CON-2 relays are operated thereby cancelling line continuity test in addition to cancelling the check of the ringing control relays. However, in all other markers, line continuity test is made on calls to the intercepting trunk group except under conditions described later.

Calls to the intercept trunk group, in any marker, cannot be arranged for end of block hunting, allotting or jump hunting, since this trunk group is limited to one twenty block per class of intercept trunk.

TROUBLE INTERCEPT SC 503 - OS 523

LINE ON PLUG UP

When a line is plugged up, a shoe is inserted at the V.M.D.F. which splits the originating end from the terminating end, placing a trunk circuit to the "A" board on the originating end and a solid ground on the tip and battery through 115 ohms resistance on the ring to the terminating end.

Calls to a line that is connected to a plugging up circuit are routed to trouble intercept trunks by the marker. These trunks are divided into two groups, local and toll, for the same reasons as for the regular intercept trunks. Each trouble intercept trunk group is represented by a route relay in the marker, these relays being designated LTI and TTI and their terminals being cross-connected as described for the LIN and TIN relays. These two trunk groups cannot be arranged for end of block hunting, jump hunting or allotting. Each trunk originates at a primary line link vertical and each group is arranged for terminal hunting.

On a call to a plugged up line, the marker proceeds as described for a regular call. When the ground test is made on a plugged up line, the ground on the tip holds the GT relay operated, thereby preventing the release of the incoming trunk F relay. The resistance battery on the ring lead causes the marker circuit PU and PU-1 relays to operate and 226-ohm battery is connected to the ST lead to the incoming link and connector circuit.

This prevents the incoming link and connector circuit from releasing.

Marker circuit PU-3 relay operates and an additional ground is connected to the FC lead.

This ground holds the F relay of the incoming trunk circuit.

Marker circuit LTI or TTI relay operates and locks.

The relay to operate is dependent upon the class of the incoming trunk as indicated by the FS, MAN and TOL relays.

Marker circuit IN relay operates, the FH relay releases and the number group connector MP- relay releases.

The release of the marker circuit FH relay removes battery from the ST lead to the number group connector circuit, causing the above release and the complete disconnection of the number group connector circuit.

The call proceeds as indicated on SC 503 and the PU-1 relay releases.

The PU-1 relay is slow release to delay the release of the incoming trunk F relay until the train of hold magnets has had ample time to release; otherwise the release of the F relay would provide a holding circuit and prevent the release of the hold magnets. The PU-1 relay prevents the release of the incoming link and connector circuit until this time to prevent another marker from seizing it, operating another F relay and possibly causing interference.

Battery is removed from the ST lead to the incoming link and connector and ground is removed from the FC lead to the terminating marker connector.

This causes the release of the F relay in the incoming trunk and the release of the incoming link and connector.

Marker circuit IK and IK-1 relays release and the SIN operates and locks.

The operation of the SIN relay makes effective the cross-connection of the LTI or TTI relay and the call proceeds as described for a regular call. The check of the ringing control relays is omitted and for special markers whether the call is special or not and line continuity test is not made because the operation of the IN relay results in the operation of the CCT relay which cancels the test.

The test for a plugging up line, ground test and false charge test are not effective on no-test, no-hunt and neither no-test nor no-hunt calls as the TT and RT leads are open at the trunk.

TROUBLE INTERCEPT SPECIAL CONDITIONS

When the CCT relay is operated for cancelling the ground test feature, the slow release of the PU-2 relay after the GT-1 operates, provides a delay which allows time to test for a plugged up line condition. As explained under "CCT Jack" the release of the PU-2 relay will open the FC lead to release the trunk, however, on a plugged up line the operation of the PU-3 relay connects a holding ground to the FC lead which will become effective before the PU-2 relay can complete its release.

A call made to a plugged up terminal hunting line will be blocked from making a trouble intercept routing on a first or second trial because neither the LTI or TTI relays can operate if the HF-1 relay is operated. The PBX recycle feature will become effective as described under "Terminal Hunting Lines - GT Loop Test or Failure - First or Second Trials." A plugged up condition encountered on a terminal hunting line after a PBX recycle will be routed to the trouble intercept operator.

LINE LINK PER CENT LOAD REGISTER

It sometimes occurs that line links receive their maximum load at only one time of the year. In view of the small size of the line links per horizontal group (10) they may be easily overloaded and, therefore, it sometimes becomes necessary to rearrange lines. To aid in detecting this condition a circuit is provided which will operate a register every time a line link horizontal group reaches a certain predetermined load.

The REG relay, the BL and BK resistances, and the REG-1, REG-2, R-5, R-6 and R-7 terminals are furnished for this purpose. The REG relay is a double wound relay and operates for any number of busy line links desired by cross-connecting terminals REG-1, REG-2, R-5, R-6 and R-7 as indicated in the following chart.

Number of Line Links Busy	REG Terminal	R Terminal
3	2	5, 6 and 7
4	2	5 and 6
5	2	5
6	None	None
7	1	5
8	1	5 and 6
9	1	5, 6 and 7

The operation of the REG relay connects ground to the PL lead to the line choice connector circuit. This ground is connected to a register through the CR and CE relays to indicate the number of times this condition exists for an entire link frame. The CR and CE relays extend this ground through the operated HG relay to the register circuit. The register circuit is controlled by a key so that a reading for the entire frame is available or by operation of the key a record is taken of each horizontal group within the line link frame.

CHAPTER 8

SECTION 8

Terminating Marker Connector Circuit	SD-25036-01
Terminating Marker Circuit	SD-25283-01
Terminating Trouble Indicator Circuit	SD-25284-01

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HEAVY TRAFFIC

The XS-1 and XS-2 relays are provided to measure the time interval between successive calls, so that in periods of heavy traffic marker holding time may be reduced by the elimination of certain tests. If the time interval between the release of the marker on the previous call and its reseizure is less than the combined releasing time of the XS-1 and XS-2 relays the operation of the marker circuit CK-5 relay holds them operated. However, with the XS-1 and XS-2 relays operated the LTR and XS-3 relays cannot operate when the CK-7 relay operates. The XS-3 relay being normal prevents the operation of the XS-4 and XS-5 relays thereby cancelling the check for crossed NS leads. Under this condition the LE-1 to 6 relays do not operate until the NK relay operates and due to the XS-5 relay being normal, the number group connector circuit TB relay operating path is closed at an earlier point, inasmuch as it is not necessary to await the release of the XS-5 relay.

Under this condition the call proceeds as for a regular call. When the HMT relay operates, it causes the operation of the HTR relay which in turn causes the operation of the GLH relay. From this point the call proceeds as in a regular call as the GLH relay performs its normal functions. However, operation of the GLH and GLH-1 relays earlier in the call causes the line hold magnet to be operated at the same time as the other hold magnets of the train and removes the winding of the FCG relay from the TT and RT leads thereby cancelling the false charge test.

Following the release of the SL relay, the LTR relay is operated in order to connect the NS lead to the RL lead and thereby supply ground to the sender as a release signal. The operation of the LTR relay at this time causes the release of the HTR relay.

MARKER RELEASE ON RINGING LEAD TROUBLES

Some of the trouble conditions which may be encountered in connection with the ringing control leads are as follows:

(a) A grounded RC lead which will change a busy back to an overflow in the incoming trunk.

(b) An open RC lead or a failure of the trunk circuit RC relay to lock resulting in no ring or changing an overflow to a busy back.

(c) A grounded TC lead resulting in no-charge to the originating subscriber or false overflow in a tip party call.

(d) An open TC lead or failure of the trunk circuit TC relay to lock resulting in a false charge to a subscriber calling a free line if the connection were permitted to be set up or in failure to return overflow or busy back and returning a false audible ring instead.

(e) A grounded RV lead which would result in ringing the tip party if the ring party were called, or to return an overflow if a free line were called.

(f) An open RV lead which would result in ringing the ring party if the tip party were called or to return audible ring on an overflow condition.

The marker tests for all of these trouble conditions and divides them into two classes; those which cause false charges (items D, E, and F) and those which do not cause false charges. On conditions where a false charge is not involved and where there is a possibility that the call may be successful if set up (grounded RC or TC lead) the marker causes the trouble indicator to take a record of the trouble and then sets the call up as if no trouble existed.

When the RC-1 relay is operated and the RC relay is normal or the TC-1 relay is operated and the TC relay is normal the XR relay operates. The operation of the XR relay opens the RV lead to the number checking trunk and opens the RL lead and connects it to the TRL lead. After the trouble indicator is connected, the operation of the TTIB relay connects ground to the TRL lead from the normal contacts of the TM-7 relay. The grounded TRL lead due to the XR relay operated is connected to the RL lead as a regular release signal.

TEST FOR RECEIVER OFF HOOK - COIN LINES

FIRST TRIAL

A pre-pay coin line with the receiver off the hook and no coin in the box places a short-circuit across the T and R leads of the line, but does not start a call to make the line busy. If a terminating call were to seize a line in that condition, the short-circuit would trip the ringing and operate the supervisory relay. The marker tests for this condition, however, and blocks or returns a busy back if it is encountered thereby preventing a false charge.

All coin lines are tested for this condition and therefore must be segregated by line link frames. In the line choice connector circuit, each Fig. 4 which represents a coin line link frame must have connected the CN wiring associated with the CR and CE relays.

When the line choice connector circuit CR and CE relays operate and are associated with a coin line link frame, the marker circuit CN-1 relay operates from ground on the line choice connector circuit CN lead.

> If a short-circuiting plug is in each of the CCT and CCN jacks, ground is connected to the CCN lead from the miscellaneous circuit for terminating trouble indicator. If this ground is present when the CN-1 relay operates, it causes the CCT relay to operate at this time.

Marker circuit CN and CNL relays operate.

> The 3200 ohm resistance in the operating circuit of the GT relay is short-circuited.

From this point the marker proceeds as described for a regular call. When the CON-2 relay operates the marker circuit GT relay winding is connected to the TT lead and ground is connected to the RT lead through the PU relay.

> If the coin line has an R.O.H. and there is no coin in the box, the GT relay holds over the loop blocking the marker, thereby causing it to time out and calling in the trouble indicator for a record. The marker then gives a trouble release to the connector resulting in a second trial.
>
> If the CCT and CCN jacks are being used and the CCT relay has operated, second trial action will take place on the first trial, without calling in the trouble indicator.
>
> If the coin line is a plugged up line, the PU relay operates at this time and the marker proceeds as described for a trouble intercept call, with the following addition.

Marker circuit CNL relay releases.

SECOND TRIAL OR FIRST TRIAL WITH CCT AND CCN JACKS

When a second trial call enters the marker because of a first trial trouble release from a coin line R.O.H., the circuit functions the same as the first trial call up to the GT relay loop test. Because of the TR-2 relay being operated on a second trial, the GT loop test is made on only coin and PBX line calls, this being controlled by whether the CN relay is up or down.

The marker functions on second trial the same as described, the GT relay failing to release when the CON-2 relay operates. When the GT-1 and GT-2 relays operate, the marker circuit CNL relay releases.

> The CNL relay is slow releasing to allow sufficient time for the GT loop test to be made. If the GT relay does release under normal conditions, the trunk F relay will release and in turn the marker SL and SI-1 relays release, this all having occurred before the CNL relay has closed its back contacts.
>
> When the CNL relay releases on a GT test failure, with either the TR-2 relay operated or the CT relay operated, and provided that the coin line is not in a PBX group in which case the HF-1 relay is operated.

Marker circuit BBT relay operates and locks.

> Connected to the contacts of the BBT relay is an ST, HB, TB and L punching for cross-connection, to indicate to the marker the location of the busy signal circuits associated with line link verticals. The BBT relay can be used for a single route per marker. These busy signal circuits will be non-charge.

The contacts of the BBT relay serve the same functions as corresponding contacts on the intercept relays. It also opens the circuit for operating the CNL-1 and CNL-2 relays and the trouble intercept relays.

Marker circuit PU-1 and IN relay operates.

The PU-1 and IN relays perform the same functions to release the number group, incoming link and line choice frames, as described for trouble intercept, except that the PU-1 relay releases after the LK-1 has released. The SIN relay in operating starts the reroute under control of the BBT relay to select a busy signal circuit.

This is to distinguish between the signal resulting from coin receiver off the hook condition and the overflow signal resulting from a shortage of line junctors in the terminating train.

A coin line having the plug up condition will operate the LTI or TTI relay without operating the BBT relay. In this case the BBT relay is prevented from operating by the slow release CNL relay.

The BBT relay will not be operated in case a coin line is in a terminal hunting group since the HF-1 relay will be operated. Instead a PBX retest takes place as explained under "Terminal Hunting Lines GT Loop Test - Second Trial." A coin line in most cases will not appear in a terminal hunting group. If a line trouble is encountered on the recycle, the BBT relay operates giving a busy signal instead of overflow.

Since the busy signal circuits will be on a terminal hunt basis, a line trouble with this route will cause the PBX retest but instead of ultimate overflow, the marker will block if the retest is not successful.

CROSS RELAYS

There are two general methods used by the marker for detecting crosses. The first is the connection of a non-marginal relay to the lead to be tested and the second is the use of a marginal relay that will not operate on a normal closure but operates if there is a cross, which produces about twice the normal current.

TEST FOR GROUNDED NF LEADS

The XS relay that was used in a regular call for testing for grounded or crossed NS leads is used for this test. The circuit is prepared for this test, and other tests, by inserting a plug in the XT jack on the trouble indicator frame. This results in the operation of the XT-2 and XT-3 relays before the marker circuit CK-5 relay operates.

The operation of the XT-2 relay disconnects battery from the windings of the HT-0 to 19 relays and connects in its place battery through the winding of the XS relay. Should one of the NF leads become falsely grounded, prior to the operation of the CK-5 relay, the XS relay operates in turn operating the X relay which locks and grounds the DL lead of the marker.

The marker thereupon times out and causes the indicator to take a record. When the marker CK-5 relay operates during a call, it releases the ST-2 and XT-3 relays thereby removing the winding of the XS relay from the HT relays and connecting direct battery in its place.

TEST FOR GROUNDED OR CROSSED HOLD MAGNET LEADS

With a plug in the XT jack, relays XT-2 and XT-3 operate as described above, thereby grounding the LG-A to LG-D leads in turn operating the correspondingly designated relays. These in turn operate the EH and OH relays thereby connecting the twenty hold magnet leads to the XT relay winding, which has 48 volt battery and a ground connected to it. The XT-3 relay operates the XT-4 relay, which is slow release to avoid false operation of the X relay at the end of the test or when the plug is removed from the XT jack.

False battery or false ground on any of these leads cause the operation of the XT relay which in turn operates the XT-1 relay. The XT-1 relay locks and operates the X relay which locks and grounds the DL lead resulting in the summoning of the trouble indicator to take a record.

As before, this test is terminated upon the operation of the CK-5 relay or the removal of the plug from the XT jack. If the XT-1 relay operates after a call has started it prevents the operation of a CH relay.

TEST FOR GROUNDED LINK AND JUNCTOR LEADS

The operation of the XT-2 and XT-3 relays as a result of a plug in the XT jack operates the LG-A to LG-D relays and in addition the LIL, RIL and JPN relays operate. The LG-A to LG-D relays close the SM leads to the winding of the XSM relay. If one of the select magnet leads is falsely grounded the XSM relay operates, in turn operating the X relay.

The LIL, RIL and JPN relays close through the incoming link and line junctor leads to the windings of the AB relays, the common LL leads from the line link frame being connected to the windings of the AB and LL relays are connected to the winding of the XT relay until the LLB relay operates. If any of these common leads are falsely grounded or crossed with battery the XT relay operates thereby operating and locking the XT-1 relay which in turn operates the X relay.

The marker circuit is so arranged that a manual test of all the above leads may be made if desired to check the frame leads. The marker is made busy and a plug inserted in the XT jack for this test. By means of a test clip, the ST terminal corresponding to any desired incoming link and connector number group connector or line choice connector circuit is connected to 226 ohm resistance battery. This extends the channel testing leads (the secondary line switch hold magnet leads and the line link primary select magnet leads) to include the common frame multiple, and all these leads except the select magnet leads are connected to the winding of the XT relay in the marker. A false ground on any lead or a cross to battery operates the XT or XSM relay.

A signal may be obtained when the XT relay operates, by connecting a lamp or a headset test clip to the XT terminal. This permits the observation of the XT relay without opening the relay cabinet. Similarly the IK, NK and LK terminals are provided for obtaining a signal that each frame is connected. These manual tests must be made during light traffic.

GROUNDED CTT OR CTL LEAD

The marker, during light traffic, as indicated by the operation of the XS-3 and LTR relays, operates the XS-4 and XS-5 relays to test for crossed or falsely grounded NS leads. In addition the XS-4 relay when operated connects the CTT and CTL leads to the winding of the XT relay. If either lead is falsely grounded or crossed with battery the XT relay operates, thereby operating the XT-1 relay which locks and operates the X relay.

GROUNDED RL OR TRL LEAD

A grounded RL or TRL lead causes senders connecting to the marker to release falsely before they have had time to function. To give notice of this condition the XRL relay is provided. If either lead is falsely grounded the XRL relay operates, locks and grounds the DB and TM leads thereby causing the timing circuit to function and cause the marker to connect to the trouble indicator.

MISCELLANEOUS X RELAYS

The following group of X relays are non-marginal and operate if the lead they are guarding becomes falsely grounded.

XL relay is used to check for a false ground on the L relay windings and is disconnected by the operation of the CK-8 relay.

XIN relay is used to check for a false ground on the windings of the LIN, TIN, LTI and TTI relays. This test is effective only if a plug is inserted in the XT jack at the trouble indicator.

XOB relay is used to check for a false ground on the BB and OF relays windings. The operation of the LLB relay removes the test from the BB relay winding and the operation of the IK, RO, OFT, TMBN, TMBL or TRO relay discontinues the test on the winding of the OF relay.

XFC and XFC-1 relays test for a false ground on the FC lead and on the GT relay winding and front contact circuit. The operation of the LTI, TTI, PU-1, PU-3, HF-2 or GT relay discontinues the test.

XR relay checks for certain ringing lead troubles.

XTL relay is used to check for a false ground on any of the TB leads to the number group connector circuits. The operation of an even numbered HP relay disconnects one TB lead from the winding of the XTL relay. It should be observed that it is necessary to operate all the even numbered HP relays to remove this test from all of the TB leads.

The following X relays are marginal relays and operate if a cross causes twice the normal current flow.

XP relay is used to detect when two or more of the JP-0 to 8 relays and the JPN relay operate simultaneously due to trouble.

XHG relay and its auxiliary XHG-1 relay detect when two or more HG relays of a line link frame operate simultaneously, due to trouble.

XF-2 relay and its auxiliary XF-3 relay operate if two or more LC-0 to 19 relays operate simultaneously due to trouble. The XF relay operates on 9 or more LC windings in the circuit.

XC relay and its auxiliary XC-1 relay operate if two or more CA-0 to 9 or CB-0 to 9 relays operate simultaneously due to trouble.

XJC relay detect two or more JC relays operated simultaneously and if operated prevents the JHB relay from operating.

XHB relay detects two or more hundred block relays of the number group connectors operated simultaneously due to trouble. The XHB relay operates the XHB-1 relay which locks.

XTB relay and its auxiliary XTB-1 relay indicate when two or more twenty block relays operate simultaneously due to trouble. The XTB relay operates the XTB-1 relay which locks.

The operation of any of the above cross-detecting relays except the XR relay results in the operation of the X relay which when operated causes the following:

(a) Opens the lead used to operate the line hold magnet except on second trial calls.

(b) Opens the RL lead to the connector circuit.

(c) Opens the RV lead to the number checking trunk frame.

(d) Opens the operating circuit of the GT-1 and GT-2 relays.

(e) Operates the DL relay to call the trouble indicator.

(f) Opens the operating circuit of the XR relay.

(g) Locks, provided that the LLB relay is normal.

In addition to the cross relays operating the X relay, if the AL and NAL relays operate simultaneously, due to trouble, the X lead is grounded resulting in the operation of the X relay.

•

If the FL and NFL relays operate simultaneously, they open the operating circuit of the hundred block relay thereby forcing the marker to time out.

SENDER TEST CALL

The automatic sender routing frame grounds the SDT lead in the connector circuit and this ground is extended through the S and TM relays of the connector over the SDA lead and is thereby connected to the ST lead to the terminating marker where it operates the marker SDT-1 relay and the receiving leads are connected to the automatic sender test circuit.

> This is done so that the test circuit may check the number and frame indication passed by the sender to the marker.

Marker circuit SDT relay operates and the operating circuits of the FH-0 to FH-19 relays is opened.

> This prevents the marker from making translation on a test call.

The start lead battery for the incoming link and connector circuit is opened.

> This prevents the seizure of an incoming link and connector circuit on a re-order call made by the sender test circuit.

Ground is connected to the FC lead.

> This is done in order to check the FC lead through the sender.

The DL-1 relay operating path is opened.

> By preventing the DL-1 relay from operating the trouble indicator circuit cannot be summoned in case of trouble on a test call.

The DL lead to the trouble indicator is opened and a path is closed from the TIB lead from the sender test circuit to the windings of the MT relay.

> This is done so that on certain trouble release tests, when the sender test circuit grounds the TIB lead the TTIB and MT relays operate, thereby preventing the seizure of the trouble indicator and the sounding of the alarms.

MARKER TEST CALL

Facilities are provided in the terminating trouble indicator circuit for making routine tests of the marker circuit. A marker can be seized for a test call by the operation of numerical, incoming frame number, and class of service keys in addition to the operation of the ST and MT keys. Operation of these keys causes certain relays in the trouble indicator circuit to operate and connect ground to the DB and MT leads to the marker. This causes the marker circuit CBR and CBS relays to operate. Ground is connected to the CB leads to the terminating marker connector circuits, causing the marker circuit to test busy.

Marker TIF relay operates and ground is connected to the winding of the XHB relay.

> This prevents the operation of the XHB relay on a test call due to the closure of the HB leads to the trouble indicator. Therefore on a test call the XHB relay is not operated in case of a falsely crossed HB lead, but this type of trouble is indicated by the lighting of more than one HB lamp at the trouble indicator.

Marker TIE relay operates and ground is connected to the MC lead to the trouble indicator circuit.

> The operation of the TIF and TIE relays in the marker connects the receiving and test leads to the indicator circuit and the above function causes trouble indicator relays to operate and extend these leads to the operated keys.

Marker circuit MT relay operates and an additional resistance is connected to the operating circuit of the GT relay.

> This provides for an operate test of the GT relay.

The winding of the DL-1 relay is connected to the RL lead and the MR lead to the trouble indicator circuit is opened.

> This prevents the scoring of the trouble release register on the trouble indicator frame.

The TIA lead to the trouble indicator is opened.

> This prevents the sounding of the trouble indicator alarm on test calls.

The winding of the XRL relay is removed from the RL lead and the GLH lead to the trouble indicator is opened.

> The marker, in connection with the handling of a test call, seizes the number group connector circuit, operates the hundred and twenty block relays, tests the desired line as indicated by the trouble indicator circuit and then seizes the incoming link and connector frame and finally the line choice connector circuit.

When the incoming link and connector circuit is connected the IK and IK-1 relays operate, causing the marker circuit MT-1 relay to operate and connecting ground to the CSG lead to the trouble indicator circuit.

> The ground on the CSG lead is an indication to the trouble indicator circuit to provide the class of trunk indication to the marker as on a test call no incoming link and connector circuit LC relays are operated.

A locking circuit is provided for the RC-1, TC-1 and RV-1 relays.

This locking circuit takes the place of the circuit normally supplied by the incoming trunk, as no incoming trunk is used on a test call.

An operating circuit is provided for the GJ relay by bridging the contacts of the BA relay.

The BA relay does not operate on test calls as no incoming link is seized.

A circuit for holding the HG relay operated after the operation of the GLH-1 relay is provided.

This is done because no line hold magnet is operated on a test call and therefore it is necessary to prevent the release of the HG relay so that the test call will not be re-routed to intercept.

Marker circuit LCT relay operates.

Inasmuch as no incoming trunk is used, this relay operates over the FC lead within the marker and takes the place of the trunk circuit F relay and the incoming link and connector circuit LC relay.

Ground is connected to the AK lead.

This permits the marker to proceed so that it can select a channel.

A circuit is provided to operate the SL relay when the GC relay operates.

Marker circuit MT-4 relay operates and the TT and RT leads are connected to the trouble indicator circuit.

This permits the trouble indicator to make tests of the continuity feature and the GT, PU and FCG relays.

The marker handles test calls in the same manner as described for a regular call except that the trunk F relay is not used and no LC relay of the incoming link and connector circuit is operated. Therefore, the incoming link leads are not closed to the marker and consequently all incoming links appear idle. However, the junctor LJ leads and the line link leads are connected through the line choice connector circuit to the marker in the regular manner and the marker selects an idle channel. After selecting a channel the marker proceeds to operate the incoming link secondary and the line link secondary hold magnets. The select magnets are not operated on the secondary switches of the incoming link frame because no LC relay is operated. Therefore the operation of a hold magnet on the incoming link secondary switch does not close a crosspoint. However, on the line link secondary switch the proper select magnet is operated and the operation of a hold magnet closes a crosspoint. This crosspoint is tested for closure of the sleeve contact and is the only one tested by the marker on a test call. Although the proper select magnet is operated on the primary line switch, the hold magnet is not operated to close the crosspoint as this path is not used on a test call.

When the marker completes its functions for handling a test call, operation of the TLH relay connects ground to the RL lead and operates the DL-1 and DL relays.

> The DL relay is operated as a result of the operation of the DL-1 relay. It can also be operated if, due to trouble, the marker circuit times out.

Marker circuit TR relay operates, causing a locking circuit to be provided for the MT relay, ground to be connected to the DB and DL lead and 226 ohm battery to be connected to the TIS lead to the trouble indicator circuit.

> This causes the trouble indicator circuit to function for a record, the TIA, TIB, TIC and TID relays being used for this purpose. The trouble indicator then connects ground to the TIB lead, operating the marker circuit TTIB relay. This relay connects ground to the TRL lead to the trouble indicator causing it to function and remove ground from the DB, MT and CI leads thereby releasing the CBR, CBS, TIF, TIE, MT, MT-1, MT-4, TIA, TIB, TIC and TID relays and thus restore the marker to regular service.
>
> In addition to the previously mentioned marker test relays the marker is equipped with the MT-2, MT-3, MT-5 and MT-6 relays. These relays are used to perform particular tests in connection with the trouble indicator and are operated when required. The MT-2 and MT-3 relays are used in testing unnumbered terminals and when operated open the operating paths of the hundred block and twenty block relays respectively and connect the leads to the trouble indicator thereby permitting the operation of any desired hundred block and twenty block relays. The MT-5 and MT-6 relays are operated on all tests for which an NS key is operated on the trouble indicator frame. The NS keys are used to force the selection of a particular unnumbered terminal, for no-test calls, no-hunt calls and number checking calls.

MARKER MAKE BUSY

A marker circuit may be made busy manually by inserting a make busy plug in its associated make busy jack at the trouble indicator frame. This causes the operation of the marker circuit DB relay which in turn operates the CBR and CBS relays which connect ground to the CB leads to the connector circuits thereby operating the CB relay associated with the marker in each connector. If the marker made busy is a special marker, the DB relay in operating connects ground to the MB lead to the other special marker, in order to supply an operating circuit for its LK-0 relay.

CHAPTER 8

SECTION 9

MISCELLANEOUS INFORMATION AND FEATURES

Incoming Link and Connector Circuit 100 Trunk Capacity	SD-25032-01
Line Choice Connector Circuit	SD-25275-01
Number group Connector Circuit	SD-25276-01
Terminating Marker Circuit	SD-25283-01
Terminating Trouble Indicator Circuit	SD-25284-01
Incoming Link and Connector Circuit 160 Trunk Capacity	SD-25457-01

MARCH 1954

TERMINATING MARKER TIME MEASURE - SC 502

The marker time measure functions are divided into two main classes, the short and the long time out. The first is actuated by a ground from the TM lead and the other from a ground on the marker DB lead.

SHORT TIME-OUT

A failure of the false charge, line continuity or ground test, or a failure of the check of the ringing control relays blocks the progress of the marker. Any open or grounded receiving lead, operation of any cross-detecting relay or any other trouble that blocks the progress of the marker prevents the connection of ground to the RL lead to the sender. Or, if the RL lead is open or the release function of the sender or connector fails, the marker remains connected to the connector until it times out.

The marker circuit short time-out is divided into six stages, as follows:

1. From the seizure of the marker to the completion of the recording relay check.
2. From the seizure of the number group to the completion of the line test.
3. From the seizure of the marker to the seizure of the line choice connector.
4. From the seizure of the line choice to release of the marker.
5. From the seizure of the incoming select magnet lock-out to the operation of the channel hold magnets.
6. From the seizure to the release of the trouble indicator circuit following one of the earlier time-outs.

The first and third stages start simultaneously when the marker is seized.

The TM interrupter and the TMS-1, TMS-2, TMW, TMZ, TML-1, TML-2 and the TM-1 to 7 relays control the short time-out and serve to summon the trouble indicator and release the marker and associated circuit.

FIRST STAGE
MIN. 1.15 SEC. TO MAX. 2.45 SEC. - SC 502, OS 526

The terminating marker connector circuit when it operates its marker multi-contact relay connects ground to the TM lead to the marker. The connector circuit also releases the marker DA-1 and DA-2 relays which close additional grounds to this lead. The TM lead grounds does not become effective in the marker until the CK-9 relay operates. With the TM lead grounded and the CK-9 relay operated the short time-out circuit functions. The TMS-1 relay operates and ground is connected to the TM interrupter, the open and closure of the back contact of the TM interrupter functions the TMW and TM-2 relays which in turn control the operation and release of the timing relays.

The B contact of the TM interrupter closes for .15 second and is open for 1.15 seconds.

The sequence of operations takes place as indicated on SC 502 and, if, due to trouble, the CK-1, CK-2, or CK-3 relay is operated or the CK-4 relay is normal the marker circuit DL relay operates followed by the operation of the TR relay.

From the connection of ground to the TM lead until the operation of the TM-1 relay 1.15 to 2.45 seconds have elapsed. If the TR relay operates, it summons the trouble indicator circuit, if available, to take a record of the call and release the marker and its associated circuits. If the TR relay operates and the trouble indicator is busy, a trouble release signal is given releasing the marker.

The DL relay does not operate if registration has been properly completed.

SECOND STAGE
MIN. 1.15 SEC. TO MAX. 2.45 SEC.

The second and third stages of timing overlap each other. The first stage and third stage started with the seizure of the marker and even though the first stage is completed the timing circuit continues to count time as indicated on SC 502 to the operation of the TML-1 relay.

The second stage timing times from the connection of the number group connector circuit until the completion of line test as indicated by the operation of the RF, TF, or HF relay. The TML-1 relay operates at this time provided that the NK and CK-4 relays are operated and the TF, HF, RF, INC, BB, TRO, TMBL, TMBN, and RO relays are released. If the NK relay is not operated the timing circuit continues to time. However, the TML-1 relay can operate during the timing stage and prior to the operation of the TM-5 relay, whenever the TMW and NK relays are operated and the TMZ relay is normal.

In addition to the circuit controlled at the NK relay, a similar circuit for operating the TML-1 and TML-2 relay is prepared when the MKO relay operates. Also, when the BB, TRO, TMBL, TMBN or RO relays operate with the IK-1 relay operated. These circuit relays allow the second stage timing interval, as follows:

(a) From seizure of number group to operation of ringing control.

(b) From seizure of incoming frame to end of call for "Busy Back", "Overflow" and "Reorder".

(c) From incoming select magnet operation to end of call.

The TMS-1 relay controls the NK and IK start intervals and the TMS-2 relay controls the MKO interval. The TMS-3 relay governs recycles, to allow reset of timing before the restart.

The timing circuit continues to time and if line test is not completed the TML-2 relay operates causing the DL relay to operate which in turn operates the TR relay.

If the TR relay operates it summons the trouble indicator circuit, if available, to take a record of the call and release the marker and its associated circuits. If the TR relay operates and the trouble indicator is busy a trouble release is given releasing the marker. From the operation of the TML-1 relay until the operation of the TML-2 relay 1.3 seconds have elapsed. The total time elapsed thus far is 3.75 to 5.05 seconds.

If line test is satisfactorily completed, as indicated by the operation of the HF, RF, or TF relay, the DL relay does not operate, as the TML-1 relay is released. If the DL relay does not operate the timing circuit continues to function as described in the next stage.

THIRD STAGE
MIN. 7.65 SEC. TO MAX. 8.95 SEC.

As stated the first and third stages started with the seizure of the marker and the second stage can be started and completed any time after the operation of the TML-1 relay but prior to the operation of the TM-5 relay. Thus far 3.75 to 5.05 seconds of the third stage have elapsed.

The timing circuit continues to time and if the line choice connector is not seized when the TM-6 operates the DL relay operates which in turn operates the TR relay.

If the TR relay operates it summons the trouble indicator circuit, if available, to take a record of the call and release the marker and its associated circuits. If the TR relay operates at this point, and the trouble indicator is busy, a trouble release is given releasing the marker. From the seizure of the marker until the operation of the TM-6 relay, 7.65 to 8.95 seconds have elapsed.

This stage, times for the seizure of the line choice connector circuit, as indicated by the operation of the LK relay. When that occurs, regardless of how far the timing circuit has progressed (provided that the trouble indicator has not been summoned, as indicated by the operation of the TM-6 relay) the TMS-1 relay releases causing the TM-1 to 6 and the TMS-3 relays to release.

Operation of the NC-9 relay on a number checking call will also cause the release of the TMS-1 relay.

FOURTH AND FIFTH STAGES
FOURTH MIN. 2.45 SEC. TO MAX. 3.75 SEC.
FIFTH MIN. 1.15 SEC. TO MAX. 2.45 SEC.

The fourth stage times from the operation of the LK relay to the release of the marker, overlapping the fifth stage. The fifth stage times from the operation of the MKO relay for select magnet lock-out in the incoming link and connector circuit, to the operation of the incoming primary and secondary hold magnets, when the MKO relay releases. This includes the maximum number of junctor subgroup retest on one call, but does not include recycles. On recycles the release of the frame connectors drops the NK, IK and LK relays, the timing being reverted to the earlier stages.

Because of the overlap between these two stages it is necessary to consider them jointly.

The operation of the marker LK relay causes the release of the TMS-1, TMS-3, TMW, TMZ and the TM-1 to TM-6 relays. When these relays have released the TMS-2 relay operates and locks and ground is connected to the TM interrupter.

On a number checking call operation of the NC-1 relay causes the operation of the TMS-2 relay, instead of the LK relay.

On number checking calls to P.B.X. groups which require end of block hunting, the PG-1 relay of Fig. 20A is operated in order to recycle the timing and avoid a false time out. The PG-1 relay releases the TMS-2 relay and prepares for the possible operation of the TMS-1 relay when the timing relays are normal. The PG-1 relay is locked to the timing relays. When the timing relays are normal the PG-1 relay releases and prepares for the reoperation of the TMS-2 for a new cycle. This occurs for each number checking end of block.

In case the PG-1 relay fails to release, a circuit is closed to introduce a short timing by means of the TML-1 and TML-2 relays, as for the second stage timing.

In case the SG relay operates a self-interrupting action results due to the SG relay function of releasing the L relay for recycle. The L relay releases the LC and in turn the LK releases. The LK relay should change the timing from the third to the fourth stage, but if the LK relay releases and reoperates on SG successive tests, the timing circuit is prevented from reaching the time-out. This occurs when SG operation is due to a cross between NS and NF leads, and to prevent failure of time-out, the SG relay when operated prevents operation of the LK relay.

Marker circuit TMS-3 and TM-4 relays operate.

When the TMW relay operates as a result of continued timing the TML-1 relay will operate.

The TML-1 relay operates at this time provided that the marker circuit MK-0 relay is operated. If the MK-0 relay is not operated at this time the fifth stage does not take place. In this case the fourth stage time-out is effective. The cancellation of the fifth stage under this condition is due to the fact that by the time the TMW and TMZ relays again reach the stage at which the TML-1 relay can operate, the fourth stage time-out is effective in summoning the trouble indicator.

The fifth stage allows 1.15 to 1.3 seconds for the MK-0 relay to operate and for the marker to perform the necessary functions to cause its release.

If the MKO relay remains operated to the point where the TMZ relay is operated and the TMW relay is released, then a circuit is closed for the operation of the TML-2 relay.

The timing circuit continues to time and if the TML-2 relay operates the DL will operate causing the TR relay to operate.

If the TR relay operates, it summons the trouble indicator circuit if available, to take a record of the call and release the marker and its associated circuits. If the trouble indicator is busy, the TM-7 relay normal and the TR and TTIB relays operated, grounds the TRL lead effecting the release of the marker. If the MK-0 relay released prior to the operation of the DL relay its release causes the release of the TML-1 and TML-2 relays. If the MK-0 relay fails to operate the fifth stage does not take place. In this case the fourth stage continues.

The timing circuit continues to time and if the TM-6 relay operates the DL will operate in turn operating the TR relay.

The operation of the TR relay summons the trouble indicator to take a record and effect the release of the marker and its associated circuits, or if the trouble indicator is busy a trouble release is given.

SIXTH STAGE
ADDITIONAL 1.3 SECONDS

If a failure occurs in the first or second stage of timing, the third stage timing continues as described up to the operation of the TM-6 relay unless the trouble indicator is successfully seized and effects the release of the marker and its associated circuits. If a failure occurs in the fifth stage the fourth stage continues as described above.

Therefore if the timing circuit is in its normal operation to complete its functions, the third or fourth stage continues and operates the TM-6 relay. This, the sixth stage, is a continuation of the third or fourth stage and times the seizure and functions of the trouble indicator. After the TM-6 relay has operated, the timing continues for an additional 1.3 seconds, until the TM-7 relay operates.

This causes the release of the twenty block relay, if operated.

Ground is connected to the TRL lead to the marker connector circuit.

This causes the disconnection of the connector circuit from the marker and the seizure of another marker, if the failure occurred on a first trial call. If the failure occurred on a second trial the ground on the TRL lead causes the release of the sender and connector circuits. If a plug is in the HD jack of the sender it does not completely release, but it does effect the release of the connector circuit.

226 ohm battery is removed from the NGB lead.

This causes the release of the number group connector circuit which in turn causes the release of the incoming link and connector circuit and the line choice connector circuit as for a regular call.

The TM-10 relay operates connecting ground to the TAP lead to the trouble indicator circuit and the TA lead to the miscellaneous circuit for the marker frame.

These leads are grounded to actuate alarms.

SPECIAL CASES OF TIMING

The short time measure functions as described above except that under certain conditions it is re-cycled or extended to meet special requirements.

The second stage of timing is of sufficient duration to cover the time needed for end of block hunt or jump hunting on a regular call. However, on calls to allotted terminal hunting groups, if the allotment is changed from the first to the second group of lines or vice versa, the NK relay is momentarily released thereby recycling the second stage. On a re-order call or a call to a busy line, the operation of the RO or RB relay, together with operation of the IK-1 relay, closes a circuit parallel to that closed by the operation of the NK relay. Therefore on calls of this type the marker must be released before the termination of the second stage or the trouble indicator is summoned.

Calls that involve the PBX re-test feature of the marker cause the timing of the fourth stage to be cancelled and the third stage to be re-started inasmuch as the LK relay is released on such calls.

LONG TIME-OUT

The DB interrupter and the TM-8 and TM-9 relays are provided for sounding an alarm and releasing the associated circuits if some trouble should occur that would prevent the short time-out relays from functioning, or if the DB lead should become permanently grounded and thus keep the marker out of service. The time-out period in this case is 28 to 58 seconds depending upon the position of the DB interrupter at the time that ground is connected to the DB lead.

When the F contact of the DB interrupter closes the TM-8 relay operates and when the B contact closes the TM-9 relay operates which opens the TBW lead.

This causes the release of the twenty block relay if it is operated.

226 ohm battery is removed from the ST lead to the number group connector.

This causes the release of the number group connector circuit, which in turn effects the release of the incoming link and line choice connector circuits, as described for a regular call.

The TM-10 relay operates connecting ground to the TAP lead to the trouble indicator circuit and the TA lead to the miscellaneous circuit to the marker frame.

These leads are grounded to actuate alarms. The circuit remains as above until the ground on the DB lead is removed, the TM-8 and TM-9 relays then release. The TM10 relay remains locked until the alarm release key on the terminating marker is manually operated.

TROUBLE INDICATOR CIRCUIT

CONNECTION TO TROUBLE INDICATOR - OS 526

A trouble indicator circuit is provided for one or two groups of terminating markers, and is arranged for connection to any marker of either group that fails to complete its functions and release in a predetermined time. The time periods are measured by the marker circuits. The trouble indicator takes a record of the call and restores the marker and its associated circuits.

When a marker circuit operates its DL relay due to timing out, or without counting time as in the case of a test call the TR relay operates.

The winding of the XRL relay is disconnected from the TRL lead and ground is connected to the DB, GLH and TIA leads.

> This actuates an alarm.

Marker circuit TRB relay operates and ground is connected to the MR lead to the miscellaneous circuit for the trouble indicator frame.

> This ground is used to score the marker trouble release register.

The operating circuit for the L- and CH- relays are opened and the RL lead is opened.

The trouble indicator DS relay operates.

> There is a DS relay in the trouble indicator circuit for each marker circuit which it serves. These relays are wired in a double transfer chain in order to provide preference and prevent double connections. Two or more DS relays can operate simultaneously, but only one can cause the associated marker circuit to be connected to the trouble indicator circuit.

The trouble indicator circuit DL relay operates.

> Two or more DL relays can operate and lock in case of simultaneous calls from the markers, or in case of calls while the trouble indicator is busy.

Ground is connected to the TIL lead to the miscellaneous circuit for the trouble indicator frame.

> This ground actuates an alarm.

Marker circuit TIA relay operates.

> In case two or more DS relays are operated, the preference starts at the last one. The marker circuit nearest to this relay consequently operates its TIA relay.

Ground is connected to the winding of the XHB relay.

> This has the effect of short-circuiting the XHB relay, to prevent its false operation when the marker is connected to the trouble indicator circuit.

Ground is connected to the NGC lead to the number group connector.

> This ground causes the associated number group NGC lamp 0 to 24 at the trouble indicator to light.

Marker circuit TIB, TIC, TID and TIE relays operate and the TI relay in the incoming link and connector operates.

> The incoming link and connector circuit TI relay is operated to prepare paths for taking a record of the incoming link primary switch and the incoming link primary switch select magnet operated for the call.
>
> In addition the multi-contact relays operated in the marker connector connect a number of leads to the trouble indicator circuit, to record the progress of the call. Of the leads that are connected to the trouble indicator, those that are grounded operate corresponding relays for this purpose.

OPERATION OF TROUBLE INDICATOR RECORDING RELAYS

The marker circuit TIA relay when operated connects ground to the FRG, SNG and CNG leads to the marker connector circuit. These leads are closed through operated multi-contact relays in the connector to the FR, SN and CN leads, respectively, to the trouble indicator. The trouble indicator circuit includes one CF relay for each connector frame installed, designated 0 to 4 or as required, five SN relays, designated 0 to 4, and four CN relays, designated 0 to 3. The FR, SN and CN leads, which are connected to the windings of the CF, SN and CN relays are so arranged that one of each of these relays operates, indicating respectively the connector frame involved, the location of the sender in the connector, and the location of the connector on its frame.

The trouble indicator also includes a maximum of twenty-five NGC relays, designated 0 to 24 and a maximum of twenty LCF relays, designated 0 to 19. The number of NGC and LCF relays installed is the same as the number of number group connector circuits and line choice connector circuits, respectively. Consequently the LCF relays installed correspond in number to the LC relays of the marker circuit. When the marker circuit TIA relay operates, it connects ground to the NGC lead which is extended through the operated multi-contact relay of the number group connector circuit to the winding of the proper NGC relay in the trouble indicator circuit. In addition the operation of the TIA relay closes through the LE, HF, TF, RF, LLG-A to D, CB-0 to 9 and the CA-0 to 9 leads. Trouble indicator relays corresponding to the grounded leads operate.

The incoming link and connector circuit TI relay operated closes 10 M leads to the trouble indicator and causes one of the 10 LC leads to be grounded, corresponding to the LC relay operated. A grounded M lead causes the corresponding M relay to operate, to indicate the incoming link primary select magnet operated, and a grounded LC lead operates the corresponding LC relay, designated 0-9, indicating the incoming link primary switch involved. In addition the TI relay grounds the F lead to the trouble indicator to operate an IF relay, designated 0 to 19, corresponding to the number of the incoming frame.

The TIB relay closes through the RC, RV, TC, LIN, LTI, TIN, TTI, OF, BB, NAL, AL, HTR, LTR, NFL, FL, TE, FCG, BC, GJ, SL, GT-2, TK, FG, SDT, FC, RL, AK, LIL, RIL, LOG, and NTT leads in addition to the leads from all the X relays of the marker circuit. The trouble indicator relays corresponding to the grounded leads operate.

The TIC relay closes ten CH leads and twenty L leads from the windings of the ten CH relays and from the windings of the twenty L relays to the windings of correspondingly designated relays in the trouble indicator. In addition the TIC relay closes the MK-0, MK-1, AL-1, AL-2 and the JG-A to JG-E leads. The trouble indicator relays corresponding to grounded leads operate.

The TID relay closes the JC-0 to 18, JF-0 to 4, JR-0 to 9, JP-0 to 8, JPN and HB-0 to 23 leads to the trouble indicator, causing correspondingly designate relays to operate if the leads are grounded.

The TIE relay closes the HP-0 to 8, TBK, GLH, CON, HB-24, CN, GC, TOL, MAN, FS, SPL, NH, NT, NC, MC, CKG, K-1, K-2, K-3, RO and TR-2 leads in addition to the receiving leads to the windings of correspondingly designated relays in the trouble indicator. The trouble indicator relays corresponding to grounded leads operate.

DISCONNECTION FROM MARKER - OS 526

The trouble indicator circuit is arranged to lock in the record and to disconnect from the marker, causing it to release its associated circuits and to restore. This takes place due to operation of the TIB relay.

Trouble indicator circuit DR, RT, RT-1, HD and GD relays operate and when the HD is operated the RT releases.

> The slow operate RT-1 relay and the slow release RT relay serve to time the period during which the recording relays operate, before the marker is released.

Trouble indicator circuit RT-1, marker circuit TIA, TIB, TIC, TID and TIE and incoming link connector TI relays release.

Trouble indicator circuit RM relay and marker circuit TTIB relay in all markers operate.

Ground is connected to the TRL lead to the terminating marker connector circuit.

The ground on the TRL lead effects the release of the marker.

Trouble indicator circuit DS relay for the marker releases.

DISPLAY OF RECORD

Each recording relay operated in the trouble indicator prepares a path for lighting a lamp which is designated so as to identify the particular function associated with its recording lead in the marker; except that, in a few cases, operation of the recording relay opens the lighting circuit of the lamp, as it is necessary to use the absence of ground on the recording lead to indicate the operation of a relay in the marker.

In response to the trouble indicator alarm, the recorded information is displayed by operation of the trouble indicator circuit LP key, which locks and operates the LP relay. The LP relay connects battery to all of the recording lamps, causing those which are grounded as a result of the operation, or non-operation in some cases, of the recording relays to light.

LAMP INDICATIONS

The lighted lamps in the trouble indicator circuit indicate the circuit conditions in the marker as follows:

The lighted G-0 or G-100 lamp indicates the marker group of the marker from which the record was taken. These two lamps are only furnished when there are two groups of markers.

The lighted DR lamp indicates the marker from which the record was taken.

The lighted DL lamps indicate the markers that failed and were released without a trouble indicator record being taken, because the trouble indicator was busy. There is one of these lamps for each marker served by the trouble indicator.

The CF, CN and SN lamps indicate the connector frame, connector circuit and sender involved, if a sender is connected. One of each of these lamps lights.

The TH, H, T, U and F lamps lighted indicate correspondingly grounded receiving leads. In each group, the numerical parts of the designations of the lighted lamps add up to the digit or incoming frame number, except that falsely grounded or open receiving leads are indicated respectively, if all the lamps in certain groups are lighted, or all lighted except one.

For example, a falsely grounded receiving lead not required for the call prevents the removal of ground from all the receiving leads to which the associated check lead is connected. Consequently in this case all the receiving leads associated with one of the marker check relays CK-1, CK-2 or CK-3 remain grounded and the corresponding lamps remain lighted. There is no interference, however, with the removal of ground from the other two groups of leads.

An open receiving lead prevents the operation of the CK-4 and CK-5 relays. This in turn prevents the removal of ground from the check leads. In this case the lamps for the open lead is not lighted, and all other lamps for leads associated with the CK-4 and CK-5 relays are lighted.

The TR-2 lamp lighted indicates that a second trial was requested by the connector.

The RO lamp lighted indicates that a re-order call was requested by the sender.

The NGC-0 to 24 lamps indicate the number group connector circuit involved.

The HB-0 to 24 lamps indicate the hundreds block lead grounded by the marker.

The HP-0 to 8 lamps indicate the hunt-progress relays operated in the marker circuit. From this indication the twenty block relay lead that was grounded by the marker can be obtained. The 0, 2, 4, 6 and 8 lamps indicate the 0, 1, 2, 3 and 4 twenty block leads, respectively, and the highest number lamp lighted corresponds to the lead that was grounded.

The LCF-0 to 19 lamps indicate the line choice connector circuit involved, there being one lamp for each such circuit.

The LLG-A to LLG-D lamps indicate the line link and group control circuit of the line choice.

The LOG lamp indicates that originating traffic was locked out of the line link and group control circuit in which the called line is located.

The HF, RF and TF lamps indicate whether the called line is a terminal hunting, ring party line or tip party line, respectively.

The CA-0 to 9 and the CB-0 to 9 lamps indicate the line link sub-group relay operated in the marker. From this indication the half choice and line link primary switch is obtained.

The L-0 to 19 lamps indicate the individual line relay that is operated in the marker circuit.

The IF-0 to 19 lamps indicate the incoming link and connector frame to which the marker is connected. There is one of these lamps for each incoming link and connector frame. There is no IF lamp indication when connection is made to the local number checking trunk circuit. This circuit is indicated only by the F-1 and F-4 lamps both being lighted.

The LC-0 to 9 lamps and the M-0 to 9 lamps indicate respectively the LC relay operated in the incoming link and connector circuit and the primary select magnet operated. The LC lamp therefore indicates the incoming link primary switch and the incoming link secondary switch horizontal. The M lamp indicates the select magnet operated on the incoming link primary switch and therefore the primary switch horizontal. Together these lamps indicate the trunk number, the M lamp representing the units digit and the LC lamp the tens digit.

The CH-0 to 9 lamps indicate the channel selection relay operated in the marker, and from this indication the incoming link primary switch vertical, incoming link secondary switch, the line link secondary switch and the line link primary switch horizontal can be obtained.

The LJ-0 to 9 lamps indicate the line junctor lead grounded to the line choice connector circuit. The vertical on the line link secondary switch is also indicated by these lamps. This only applies for first choice line junctors, with JGA lamp lighted.

The JP-0 to 8 and the JPN lamps indicate the junctor pattern relays that should be operated in the marker circuit.

The JG-A to JG-E lamps indicate the line junctor group relay that should be operated in the marker circuit.

The MK-0 and MK-1 lamps indicate that similarly designated relays in the marker circuit should be operated.

The JF-0 to 4 lamps indicate the twenty block to which hunting was jumped.

The AL-1 and AL-2 lamps indicate a circuit to operate the respective allotter relays in the marker circuit.

The JC-0, 2, 4, 6, 8, 10, 12, 14, 16 and 18 lamps indicate that similarly designated relays in the marker should be operated to determine the terminal in a twenty block at which hunting starts in the twenty block to which hunting is jumped.

The RC, RV and TC lamps indicate the operation of similarly designated relays in the marker circuit.

The OF and BB lamps indicate that similarly designated relays in the marker should be operated.

The LIN, LTI, TIN and TTI lamps indicate the operation of similarly designated relays in the marker circuit.

The SPL, NC, NT and NH lamps indicate that similarly designated relays in the marker circuit should be operated.

The FS, MAN, TOL, SDT and NTT lamps indicate that similarly designated relays in the marker circuit should be operated.

The CN lamp indicates that the called line is a coin line.

The following lamps indicate various functions of the marker circuit and are for the purpose of indicating the progress of the call through the marker.

The CKG lamp indicates that the corresponding lead is grounded by the connector circuit.

The K-1, K-2 and K-3 lamps indicate respectively that the leads associated with the CK-1, CK-2 and CK-3 relays respectively were grounded.

The PG, TBK and LE lamps indicate that the correspondingly designated relays in the marker circuit should be operated.

The FC, AK and RL lamps indicate that similarly designated leads were grounded.

The LIL, RIL, SL and TE lamps indicate that similarly designated relays in the marker circuit should be operated.

The BC, GJ and TK lamps indicate the operation of correspondingly designated relays in the marker circuit.

The FCG, GT-2, CON and GC lamps indicate that similarly designated relays in the marker should be operated.

The GLH lamp indicates the operation of the GLH-1 relay in the marker circuit.

The TRL lamp indicates that the TRL lead is grounded.

The following lamps indicate trouble relays operated in the marker circuit. These relays when operated prevent the marker from completing a call, when the leads they test are falsely grounded or crossed.

The X lamp indicates the operation of a cross test relay.

The XF lamp indicates two or more windings of one LC relay or the windings of two or more LC relays energized.

The XC lamp indicates two windings of a CA-0 to 9 or CB-0 to 9 relay energized or the windings of two or more relays energized.

The XHG lamp indicates two or more HG relays of the line link and group control circuit operated.

The XIN lamp indicates a false ground on the winding of the LIN, TIN, LTI or TTI relays of the marker circuit.

The XOB lamp indicates a false ground on the windings of the BB or OF relays of the marker circuit.

The XR lamp indicates a falsely grounded RC or TC lead.

The XRL lamp indicates a false ground on the RL or TRL lead.

The XS lamp indicates falsely grounded or crossed NS leads.

The XSM lamp indicates a falsely grounded select magnet lead or two or more leads crossed.

The XT-1 lamp indicates a false ground or cross with battery on the HM, LL, IL or LJ leads.

The XTB lamp indicates the operation of two or more twenty block relays.

The XP lamp indicates the operation of two or more JP-0 to 8 or JPN relays.

The XTL lamp indicates a false ground on the TB leads.

The XFC lamp indicates a falsely grounded FC lead.

The XHB lamp indicates the operation of two or more hundred block relays.

The XL lamp indicates a falsely grounded winding of one of the L-0 to 19 relays.

The following lamps give additional information pertaining to the marker involved on the failure.

The FL lamp indicates a call to a free line.

The NFL lamp indicates a call to a non-free line.

The AL lamp indicates the use of the allotter circuit.

The NAL lamp indicates a non-allotted call.

The LTR lamp indicates that the marker is functioning for light traffic.

The HTR lamp indicates that the marker is functioning for heavy traffic.

RELEASE OF THE TROUBLE INDICATOR CIRCUIT

To extinguish the lighted lamps and return the trouble indicator circuit to normal, the RL key is operated momentarily. This causes the trouble indicator circuit KR relay to operate and any operated DL relay to release.

The lighted DL lamps are extinguished.

The operated DR relay in the trouble indicator circuit releases.

The corresponding DR lamp is extinguished.

Trouble indicator circuit HD, KR, GD, RM and operated recording relays release.

The trouble indicator lamps are extinguished.

Marker circuit TTIB relays release in all markers.

TROUBLE INDICATOR MAKE BUSY

A make busy jack, designated TIB, is provided in the trouble indicator for each associated marker, so that the trouble indicator may be made busy to any or all marker circuits as desired. These jacks are mounted on the trouble indicator frame. Insertion of a plug with the ring and sleeve strapped in one of these jacks connects ground to the TIB lead of the associated marker, thereby making the trouble indicator busy to that particular circuit.

INCOMING LINK AND CONNECTOR CIRCUIT

REMOVING A PRIMARY SWITCH FROM SERVICE

In order to remove an incoming link primary switch from service, each of the ten to sixteen incoming trunks terminating at the switch must be made busy at the originating office.

REMOVING A SECONDARY SWITCH FROM SERVICE

Each incoming link and connector frame is equipped with ten MB jacks, designated 0 to 9, used for making the corresponding secondary switches or the secondary switches and their associated extension switches busy. Insertion of a plug with the tip, ring and sleeve strapped in one of these jacks removes the operating ground for the ten select magnets of the corresponding secondary switch, opens the S leads of the twenty links which terminate at this switch, and connects ground to these leads toward the marker circuit.

The left and right S leads at any one of these MB jacks have the same numerical designation as the jack and the associated secondary switch or secondary and extension switches. These leads are strapped at corresponding contacts of the ten LC relays for association with the primary switch verticals, in each switch, of the same number as the secondary switch involved. The ground lead for the ten secondary select magnets also has the same numerical designation and is strapped at the LC relays.

The removal of a secondary switch from service affects only two links in each primary switch, these being the left and right links of the same number as the secondary switch.

MARKER LOCK-OUT AND FRAME PREFERENCE

As described for a regular call, there is an MP relay in the incoming link and connector circuit for each marker circuit. These relays are wired in a chain circuit for preference in case of simultaneous calls from two or more markers and to prevent double connections.

Each incoming link and connector circuit also includes a corresponding set of E relays, wired to perform the same functions as the MP relays. The circuit is arranged for automatic throwover to the E relays if trouble should develop in the MP relays, to prevent delay in the markers.

With all of the MP relays normal, the windings of the CH relay are energized from ground through the two chain circuits formed by the normal contacts of the MP relays. Under these conditions the CH relay does not operate as it is differential. It operates when only one of its inductive windings is energized, which would occur if one of the chain circuits remained open with the other one closed.

The circuit functions if one of the ground chains should be opened, due to a trouble, with the MP relays normal. If an MP relay should operate and open only one of the chains then the CH relay operates.

The CH relay is slow operate to prevent its operation if one ground chain should be opened slightly before the other one is opened, in regular operation.

Incoming link and connector circuit TR-1, TR-2, TR-3, TR-4, TR-5 and TR-6 relays operate.

Ground is connected to the CH lead to actuate an alarm and the ST, MC and CK leads for all markers transferred from the MP relays to the E relays.

The CH lamp lights and the CH relay releases.

The operation of the TR- relays disconnects the windings of the CH relay from the MP relays and connects them to the E relays. This causes the CH relay to release as both windings are energized.

The marker circuits can now continue to connect to the incoming link and connector circuit, using the E relays. The alarm may be discontinued by operation of the locking type SA key.

This causes the CH lamp to be extinguished, ground to be removed from the CH lead and changes the locking path of the TR-1 relay.

If the chain circuits should fail while the E relays are being used, the CH relay would operate as before and release the TR-1 relay. This in turn would release the TR-2 to TR-6 relays, transferring the ST, MC and CK leads back to the MP relays, giving the alarm and lighting the CH lamp. In this case the alarm may be discontinued by releasing the SA key, which removes ground from the CH lead and extinguishes the CH lamp.

With either the MP relays or the E relays in use and with the SA key respectively normal or operated so that the alarm is not in operation, manual throwover to the other set of relays may be accomplished by momentary operation of the non-locking MTR key followed by the operation or release of the SA key as required. The MTR key causes the CH relay to operate by opening the circuit through one of its windings. This causes the TR relays to operate or release as before, transferring the leads and giving the alarm. Subsequent operation or release of the SA key stops the alarm.

For offices that do not require mate frame operation, use Fig. 11 for controlling the operation of the secondary select magnets.

MANUAL TRANSFER TO EMERGENCY MARKER LOCK-OUT AND SELECT MAGNET PREFERENCE

The ESM keys of Fig. 8 and 9 are provided so that in the event that a trouble condition is encountered on the regular preference and lock-out relays, the markers may be signalled to use the emergency preference and lock-out relays on the first attempt. Otherwise, a marker would first time-out and then make a second trial. By the use of the ESM keys, this eliminates the marker time-out delay on each call through the frame while the trouble is being cleared.

When an ESM key is operated it lights the ESM lamp and connects a resistance battery to its associated ESM lead. When selected by a marker the ESM, TR and TR-1 relays operate.

Ground is removed from the windings of the FP relays and battery and ground is connected to the windings of the FE and ES relays on both the even and odd incoming link frame.

> By the transfer to the frame emergency relays FE and FS the marker and incoming link frames function as described for marker lock-out and secondary select magnet preference.
>
> Ground on the ESM lead with the ESM key normal has no regular function, but is intended as a safeguard against any trouble condition which might connect battery to this lead. This would cause the emergency relays to be used at all times without any indication thereof.

LINE CHOICE CONNECTOR CIRCUIT NUMBER GROUP CONNECTOR CIRCUIT

Each of the above circuits is provided with a regular and emergency set of marker lock-out and control circuit relays that function in the same manner as described for the incoming link and connector circuit.

TROUBLE MAKE BUSY JACK

If a trouble condition exists in a line choice connector circuit or a number group connector circuit that causes excessive delays or markers attempting to complete calls within the particular circuit. By means of the TMB jack it is possible to return overflow on all calls to that frame. Since a large number of subscribers may have their terminating traffic blocked under this condition, the TMB jack should be used with great care.

The 226 ohm resistance battery on either the number group or line choice connector frames has the same functions. For this reason only the number group connector will be explained.

Number group connector circuit TMB relay operates, all marker ST leads are split and turn back to the marker TMB leads.

The splitting of the ST leads and turning them back to the marker TMB leads prevents the selection of the number group and gives an immediate signal to the marker that the number is not available.

When a marker desiring the use of the number group made busy, operates its HN- relay and connects battery to the start lead, the marker circuit TMBN and OF relays operate.

From this point the marker functions as described for the OF relay, except that the TMBN relay shunts the break contact on the YB relay, preventing the start battery for the number group connector from being opened, which occurs on regular calls.

Should the TMBN relay be operated falsely, with the presence of ground on the CK lead from the number group connector, the XTMB relay operates and calls in the trouble indicator.

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CHAPTER 9

SECTION 1

METHOD OF OPERATION

Multi-Frequency Current Supply and Distribution Circuit	SD-95391-01
Test Current Supply Control Circuit	SD-25784-01

MARCH 1954

Complete OS and SC's for the M.F. current supply and distribution circuit will be available at a later date. The following written material is presented on a temporary basis to be used with OS 420-1 and the SD drawings.

METHOD OF OPERATION

GENERAL

In order that a better understanding will be gained from the descriptive information in this step, relating to the operation of a vacuum tube oscillator, some basic knowledge is required in inductive reactance, capacitive, reactance and resonance as applied in audio-frequency circuits. For this reason, the following general information, while limited in its scope, is provided for those who have not had any previous background.

INDUCTANCE RM. 9-1

When an E.M.F. is connected to a dc circuit, the conditions are somewhat analogous to those obtained when a locomotive starts a train. The locomotive exerts considerable force which, in the circuit, corresponds to the impressed E.M.F. A part of this force is used in overcoming resisting forces such as the friction of the moving wheels, the grade of the track and others that apply to the train as a definite resistance to its motion at all times. The second part of the force is used in setting the train in motion, i.e., accelerating the heavy inert body. As soon as the train is accelerated to full speed, the entire force applied is available for overcoming the resistance along. Likewise in the electric circuit, for any given E.M.F., the current does not instantaneously establish itself to that value which represents the effect of the full voltage overcoming the resistance.

We know that there is a magnetic field about every current-carrying conductor, and when a conductor is wound into a coil or is in the presence of iron, the magnetic field is intensified. The magnetic field cannot be established instantaneously any more than the train can be instantly changed from its state of rest to that of full speed. What actually happens in the case of the electric circuit is that the E.M.F. endeavors to start a current; the current, in turn, must establish a magnetic field; this field reacts upon the circuit and for an instant a part of the E.M.F. that is connected to the circuit must be used in overcoming these reactions. The current, therefore, increases gradually and as it does so, the magnetic field becomes more nearly established and the reaction becomes less pronounced until finally the entire E.M.F. is applied.

To better understand this theory, assumed that when an E.M.F. is applied to a coil of wire, that we consider only one turn of the coil. We can imagine the current building up and in consequence establishing lines of magnetic induction around this single turn which will, however, cut ivery other turn of the coil as illustrated in RM. 9-1. This action will set up in the other turns a back E.M.F. (induced E.M.F.) tending to establish a current in the opposite direction. But with the impressed E.M.F. remaining constant, the current gradually builds up and the magnetic field becomes fixed in its motion; hence, the induced E.M.F. becomes zero and consequently no induced current. From this we can conclude that there must be a compromise trent for the current curve as it establishes itself somewhere between two extremes. The current does not maintain the same rate of change as it approaches it fixed value nor does it cease entirely its increase after it reaches its fixed value. This is true because although the induced E.M.F. that would stop the change in current is gradually becoming less in value, the voltage drop is becoming greater, and the sum of these two must always equal the impressed voltage. Thuse we see the "choking" or "retarding" effect which an inductively wound coil has on increases in current value.

The case of a decreasing current value and the E.M.F. induced at the time of opening a circuit is, of course, another application of the same theory, but the effects are different in their practical aspects. Because this E.M.F. is induced as a result of a decreasing current instead of an increasing one, it aids rather than opposes the existing E.M.F. Moreover, the current change is a very rapid one because the opening of the circuit tends to change the resistance of the circuit from a definite value to infinity with great suddenness. As a result, the induced E.M.F. may become much greater than the applied E.M.F. besides being additive to it, whereas in the closed circuit, it can never be greater than the applied E.M.F. This total E.M.F. of the opening circuit tends to force an arc across the contacts, which is more evident than the arc at the time of closing the circuit because the voltage is so much greater. Here we have again the analogy to inertia where we suddenly attempt to stop a moving body, whereas the previous analogy covered the starting of the body from a state of rest.

Briefly, the property of inductance in a circuit will cause the establishment of an E.M.F. opposing that applied to the circuit in the case of an increasing current and aiding the applied E.M.F. in the case of a decreasing current.

CAPACITANCE

There is that property of a circuit that we call "capacitance", which gives it something analogous to elasticity. While a battery sotres electricity as another form of energy, in a smaller way an electrical condenser or capacitor stores electricity in its natural state. If a capacitor is connected to a direct source of E.M.F., there will be a rush of current in the circuit. This will charge the capacitor to a potential equal to that of the battery, but the current will decrease rapidly and become zero when the capacitor is fully charged. In other words, current will only flow while the plates are being charged. If now the battery is disconnected and the capacitor short-circuited, the quantity of electricity stored in the capacitor is discharged, establishing an instantaneous current in the opposite direction to which it was charged. Thus condensers in a circuit might be thought of as reservoirs, in which electricity is being stored at the instant when the pressure is rising. These condensers then use the pressure of the stored charge to maintain the current at the instant when the pressure is dying out.

THE ALTERNATING E.M.F.

The reactions found in circuits with an alternating E.M.F. (current) are considerably different from those with a dc source. Here we have a voltage which gradually increases to a maximum value, then decreases to zero, again increases to a maximum value in the opposite direction and then again decreases to zero as illustrated in RM. 9-2. This is known as the "sine wave" (waveshape) and constitutes a complete cycle which then continues to repeat itself. For convenience, a cycle is divided into 360 degress. Any point in the cycle is spoken of as a certain "phase." Thus when the cycle is half completed, it is said to be at the 180-degree phase; when one-fourth completed at the 90-degree phase. The waveshape will be determined by the rapidity with which the alternations take place. Therefore, the following must be known for a source of E.M.F.:

a. The waveshape of the alternating cycle.

b. The value of the E.M.F. at some specified point in the cycle.

c. The length of time to complete the cycle or the frequency of its repetition in a given time.

Sine waves have several very important properties which make it much easier to treat and analyze their effects in circuits. Sine waves of the same frequency can be added or subtracted either in or out of phase and the result will be a sine wave. This means, for instance, that the sine wave currents flowing in two branches of a parallel circuit will joint to form a new and different sine wave current in the leads to the junctions of the parallel arms. A sine wave E.M.F. also causes a sine wave current to flow in resistors, inductors or capacitors. Conversely, a sine wave current through an inductor induces a sine wave E.M.F. to appear across the plates of the capacitor.

INDUCTANCE IN THE AC CIRCUIT

We know from previous statements that with direct currents, the current passing through a resistor always creates a voltage drop which is directly opposed to the impressed E.M.F. This same thing holds true with an alternate current. In other words, at any instant the alternating current in a resistor is proportional to the impressed E.M.F. This means that the current and voltage are in phase in a purely resistive circuit.

If we now introduce an inductor or capacitor into the ac circuit, this phase relationship no longer holds true. It will be remembered from previous information that when a dc voltage is connected to an inductor, the current does not immediately build up to its full value. The effect of inductance in the circuit can be likened to inertia of a mass of water before a steady flow can be set up. Perhaps a more vivid example of this inertia effect occurs in the flywheel. It will be recalled that considerable effort is required to set a flywheel in motion. Also the force required to stop the flywheel when it has started rotating is much greater than that required to keep it in steady rotation. The faster we try to accelerate the flywheel or the more rapidly we attempt to stop its motion, the greater is this force. The electromotive force induced in an inductor through which a rising current is flowing corresponds to the force opposing the acceleration of the flywheel. Conversely, the E.M.F. induced by the collapsing magnetic field in an inductor when the current is falling ties to keep the current flowing at the same rate and corresponds to the force set up by the flywheel against any attempt to stop its motion.

It can be stated that the induced voltage in an inductor is proportional to the rate of change of the current through the inductor and opposite to the impressed voltage causing the current flow. When we now draw a diagram of the relationship between the impressed voltage and the alternating current through an inductor, the result will be as shown in RM. 9-2 (effect of inductive reactance). It will make analysis of these curves easier of we remember that there must be an induced voltage across the inductor equal and opposite to the impressed voltage. Therefore, let us start with a current flow that will produce such an induced voltage. The rate of change of the current, represented by the slope of the current curve is greatest as it crosses the zero axis at point A. Therefore, the induced electromotive force must be greatest and in a negative or opposing direction at this point. As the current stops rising at the top of the curve, its rate of change is zero. Therefore, the induced voltage must be zero at this time. At point B, the induced E.M.F. will again be maximum but it will be in a positive or aiding direction. If follows from this that the induced electromotive force must be 1/4 cycle or 90 degress behind the current. Since the induced electromotive force must be equal and opposite to the impressed electromotive force, the current may be said to lag 90 degrees behind the impressed voltage. The symbol used to denote inductance is L.

CAPACITANCE IN THE AC CIRCUIT

The effect of capacitance in the circuit is exactly opposite to that of inductance. This is illustrated in RM. 9-2 (effect of capacitive reactance). Here, when the impressed voltage is at its maximum positive value as shown at point A, the capacitor is charged to a value equal and opposite to the impressed voltage. The current is, therefore, zero. As the positive impressed voltage. The current is, therefore, zero. As the positive impressed voltate decreases toward zero, the opposite voltage of the capacitor forces current to flow in the negative direction. The negative current reaches its maximum value when the impressed voltage becomes zero. Now the impressed voltage reverses, becoming negative and as it rises to its maximum negative value shown at B, it charges the capacitor in the opposite (positive) direction. During this time, the negative current decreases to zero as the capacitor becomes fully charged. Then as the negative impressed voltage decreases from its maximum, the capacitor voltage again takes control and causes the current to build up in the opposite direction. Relationships are, therefore, as shown in RM. 9-2 with the current leading the voltage by 90 degress. From the above, it can be seen that for each cycle of ac, the current charges and discharges the capacitor two times.

The symbol used to denote capacitance is C.

REACTANCE

The effects of inductance and capacitance which oppose the flow of current through the circuit are known as reactance. The inductive reactance is proportional to the rate of change of the current value and to the value of the inductance in the circuit. Since the frequency of the current is a measure of the rate of change of the current, the inductive reactance will become proportionately greater as the frequency increases. Therefore, an inductance is used to block high frequency currents and pass low frequency ones.

The effect of capacitive reactance is directly opposite to that of inductive reactance. The reactance of a circuit containing capacitance will decrease as the frequency increases. Also, as the capacitance increases, the reactance will decrease. Therefore, a capacitance is used to block low frequency currents and pass high frequency ones.

We can draw the conclusion that in any series circuit containing capacitance, inductance resistance, if the inductive reactance is greater than the capacitive reactance, the current will lag the impressed voltage, and if the capacitive reactance is greater than the inductive reactance, the current will lead the voltage.

IMPEDANCE

The term impedance is used to indicate the net effect of the combination of capacitance, inductance and resistance in an ac circuit. The impedance of a circuit is stated in terms of ohms at a particular frequency. The symbol used to denote impedance is Z.

RESONANCE

There remains the special case in which the inductive reactance and capacitive reactance are equal. This condition is known as resonance. When it occurs in a series circuit, the inductive reactance cancel out at a particular frequency and the sole impedance of the circuit is the resistance.

An application of the resonant prinicple is the so called tuned circuit or the resonant circuit used for selectivity. It is an arrangement whereby the circuit has a much lower impedance to some particular frequency than to any other frequency. If a band of frequencies is impressed, the resonance circuit selects, so to speak, a high current for the particular frequency but permits only a small current for any other frequency.

Another application of the resonant principle is in the parallel-resonant circuit (sometimes called the antiresonant circuit). In this arrangement, the inductor and the capacitor are in parallel. For this condition, when the positive reactance is equal and opposite to the negative reactance, and provided the resistance of the inductor is low, the combined impedance presented to the generator is extremely great and there is a minimum load on the generator. In other words, the generator circuit is practically open. Therefore, at the resonant frequency the two parallel reactances combine to give an extremely high impedance. The current through the inductor will be 90 degrees behind the impressed voltage. The current through the capacitor will be 90 degrees ahead of the impressed voltage. The result will be that when these two currents flow into the line to the generator they will cancel each other out and no current will flow to the generator. The physical explanation here is that a current is oscillating around through the inductor and capacitor, with the E.M.F. of the generator merely sustaining this oscillation.

THE DECIBEL (db)

The decibel is the expression of gain or loss in the power levels of transmission in telephone circuit. As in any other quantity, we require some unit of measurement when dealing with the energy losses due to attenuation of the transmission of human speech or in the transmission of any alternating current from a sending device to a receiving device. The decibel itself has no quantitative value, but rather defines the ratio in which two quantities may differ from each other. To have a plint from which to start and express the magnitue of power, a zero reference level of 0.001 watt was selected because it represented the approximate output of the average telephone. Today it is not necessary to think in terms of mathematical ratio because there are instrements available which permit the measuring or power levels and which have scales in direct decibel readings. These instruments are rectifying type alternating current voltmeters, with a dial calibrated to read in decibels rather than in volts. With instruments of this type, it is necessary that they be either used on circuits of the same impedance as that which the instrument is designed for, or that a correction factor be included or applied to the reading obtained.

THE THYRITE VARISTOR

The Thyrite Varistor is a resistance unit which consists of finely ground granules of silicon carbide firmly embedded in a ceramic material which has been fired and pressed under great pressure into tablet size. The opposing faces of the tablet are provided with a thin layer of sprayed tin and copper which provides a suitable place for attaching electrodes.

The electrical characteristic of this varistor is that its resistance decreases rapidly and disproportionately as the voltage across its electrodes increases. As an example, one of these varistors with 10 volts across its electrodes, possesses a resistance of nearly one million ohms but if 100 volts is across the electrodes, the resistance is only 100 ohms. This is essentially a higher voltage device than the more commonly used copper-oxide varistor and its resistance is independent of the polarity of the applied voltage hence, it cannot be used to rectify an alternating potential.

Varistors of widely varying characteristics are obtained by changing the size and thickness of the tablet or by varying the temperature at which the ceramic material is fired. Consequently it is possible to construct a thyrite varistor for almost any circuit where its characteristics may be required.

THE OSCILLATOR

The oscillator in its design provides for four functions; (1) amplification, (2) frequency determining network, (3) amplitude control and (4) feedback in phase.

It should be understood that an oscillator perpetuates itself by a feedback to the input circuit in phase with the input signal. It functions on the basis of the more gain, the more is fed back; the more feedback, the more gain, etc. This principle is utilized in the design of oscillators..

The feeding back of some of the output and its reamplification might appear to be an uncontrolled process. However, the magnitude of the oscillations is limited by circuit losses, plate voltages, tube characteristics, etc. The frequency of the oscillations is determined by the inductive, capacitive and resistive constants of the circuit. By properly choosing the reactive components of the oscillator tank circuit, it can be tuned to oscillate at the desired frequency. Oscillators which use inductors and capacitors for the frequency determining elements are known as LC oscillators.

The oscillator which we are to study is an LC electroncoupled oscillator, a feature of which is its frequency stability. This is obtained by using a second or screen grid as the plate for the oscillator circuit, and using the plate itself as a coupler to the load. As a result, load variations do not affect the frequency of the oscillating circuit. In addition, it is possible to so choose the plate and screen voltages that a change in the supply will cause the plate and screen voltage changes to have opposite frequency effects. This results in some cancellation of frequency errors due to variations in supply voltages.

CURRENT SUPPLY FOR GROUP OSCILLATORS

Two group oscillators are provided in one central office building to supply the frequencies for all "A" positions arranged for multifrequency operation and for testing purposes in No. 1 crossbar offices. One is known as the even oscillator group and the other, the odd oscillator group. The two are provided so that in an emergency one may carry the complete load.

In a building where No. 1 crossbar central offices have multifrequency operation for incoming calls only, and there are no "A" positions requiring M-F operation, only one group oscillator is provided. This group oscillator is provided for testing purposes only in the crossbar offices.

One oscillator group consists of six 328A vacuum tubes, each arranged in the circuit to function as a high gain pentode tube oscillator. The filaments of three tubes are wired in series and connect to one figure 6 for their 48-volt supply. This requires two figures 6 for the six tubes. The series resistances associated with one figure 6 are strapped out to the extent of giving a 22-1/2-volt reading across the B and G leads.

The cathode voltage is 48 volts and is supplied from Fig. 16 through PL and PL-1 relays. The total space current for the six tubes is sufficient to hold operated the PL relay. The PL-1 relay is marginal and remains normal so long as the drain for the cathode voltage is normal.

The plate and screen grid voltage can be between 110 and 130 volts. In Manhattan Area, this supply is taken from the positive (+) coin collect battery which is supplied by the ringing machine. This voltage varies between 115 and 120 volts, the 120 volts being its maximum. In order for the oscillators to maintain their proper output, this voltage should never be allowed to drop below 110 volts. The fuse for the positive coin collect battery supplied to each oscillator group is located on the miscellaneous fuse panel, generally in the same miscellaneous bay line up containing the group oscillators.

The Plate and screen grid voltage is connected to the group oscillator through the P resistor lamp and the PL reatrdation coil. The retardation coil blocks any noise from this supply while the resistor lamp varies in resistance depending upon the load.

The control grid each vacuum tube has a fixed negative bias in respect to the cathode and is supplied through the 1 meg. ohm B- resistor. Of course, the feedback is superimposed onto this negative value to keep the alternating swing required of the oscillator.

The tank circuit consisting of the A- capacitor and the L- retardation coil (inductor) vary in their capacitance and inductance, the values decreasing for each frequency from 700 to 1700 cycles. This gives an impedance value for controlling the point of resonance and the amount of feedback for each of the particular frequencies.

THEORY OF OSCILLATOR OPERATION RM. 9-3

For the purpose of this description and its reference, the 700 frequency oscillator will be used.

In this oscillator circuit, the frequency and amplitude controlling bridge is arranged in the form of a Wheatstone bridge. Two arms of the bridge are formed by the high windings of the output transformer TO. The third arm is the resistor which is mounted in the VRO varisto unit and the fourth arm is an antiresonant circuit consisting of the inductor coil LO and the capacitor AO in parallel. A part of the inductance of coil LO is shunted by the thyrite varistor VRO. A blocking capacitor BO and a grid leak resistor BO are provided to isolate the grid of the tube from the dc component of the plate voltage.

The impedance presented by the arm of the bridge consisting of inductor coil LO, capacitor AO and varistor VRO depends upon both the frequency and the amplitude of the voltage across the arms. At the frequency of antiresonance, this impedance is a pure resistance slightly larger than the resistance in the opposite arm consiting of the resistor unit mounted with the varistor. For frequencies above or below the antiresonant frequency, it is respectively a capacity or an inductive reactance of a magnitude becoming smaller as the frequency departs farther from antiresonance. The thyrite varistor VRO makes the impedance responsive also to amplitude variations. Taps are provided on the inductor coil LO to allow adjustment of the resultant "damping" of the antiresonant circuit. If it is ever necessary to change the thyrite varistor a transmission measuring set must be used to check the output on that particular frequency. The connection of the new varistor to the same tap on the LO coil that had formerly been used may produce a slight difference of frequency and output. These effects of frequency upon the phase angle of the impedance near antiresonance, and of amplitude upon the magnitude of the antiresonant impedance are used as described later to stabilize the frequency and amplitude of the oscillations.

With the aid of RM. 9-3, suppose that the lead from the control grid of the VO vacuum tube is disconnected from the BO capacitor and that a test signal from an external source having a normal operating frequency and a normal operating voltage is applied between ground and the control grid. This signal voltage, amplified by the tube will appear at terminal #1 of the LO inductor and will be 180 degress out of place to the input signal on the control grid. This reversal of phase may be explained by the fact that the normal potential between the plate and cathode of the tube is 163 volts. When the input signal causes the control grid to become less negative, more current will flow thru the adjacent network of the circuit causing a larger drop of potential across this network than when the control grid is at normal. This causes a lowering of the plate voltage. Conversely when the control grid becomes more negative, less current will flow thru the adjacent network causing a smaller drop of potential across these parts and results in raising the plate voltage. Considering the sine wave, the input signal is in its positive half or above the line, while the output at terminal #1 is in the negative half or below the line.

At terminal #6 of the inductor LO, the phase is again the same as the input signal because of the 1:1 ratio of the autotransformer arrangement of the high windings of the TO transformer. Part of the signal in the #5 and #6 winding of the TO transformer is induced into the #7 and #8 winding, the phase being reversed by this induction. Therefore, at terminal #6 of the inductor LO, the phase is now the same as that portion of the signal being applied. This equal and opposite signal at terminals #1 and #6 of the inductor LO are added together through the antiresonant network and the resistance associated with the VRO varistor, so that their resultant product gives a small potential at the BO capacitor.

For the normal frequency and amplitude, the impedance of the antiresonant network (LO inductor and AOO capacitor) is resistive and slightly larger than the resistance arm located in the varistor. If it were identical to the resistance arm, there would be a complete cancellation of the two signals and no voltage would appear at terminal #6 of the LO inductor. Actually, the transmission from terminal #6 predominates slightly, giving a signal at the BO capacitor which is identical in phase and amplitude with the signal being applied at the control grid, and, if connected together, this voltage will sustain itself and continue the oscillation indefinitely.

If the amplified test signal is lightly lower in frequency when applied to the control grid than the impedance of the antiresonant circuit, the antiresonant circuit would then become slightly inductive. This would shift the phase of the unbalance potential at the BO capacitor in such a direction as to make it lead the applied signal. If the BO condenser is now connected to the control grid, we may think of this leading feedback as counteracting the lagging tendency assumed at the control grid. Similarly, and increase in the frequency above the impedance of the antiresonant circuit is opposed by a feedback wave of lagging phase.

The amplitude stabilization is controlled by the thyrite varistor and may be described as follows. If the test signal voltage is made slightly smaller than its normal value, the amplified voltage across the antiresonant circuit is reduced and the resistance of the antiresonant circuit is, therefore, increased by the varistor. This further unbalances the bridge and gives an increased feedback amplitude to the control grid. Similar action applied to prevent a tendency toward increased amplitude. For low voltages, the varistor has a very high effective resistance but its value decreases rapidly as the amplitude of the voltage is increased.

Because of the high gain of the pentode tube, the grid swing needs to be only a volt or two (depending upon the external load) to give the normal signal amplitude of 92 peak volts between the plate and ground. Thus the bridge operates quite clost to balance and is very sensitive in its controlling functions. For example, suppose an external load is drawn from the circuit between plate and ground. This load might be expected to dominish the voltage amplitude at the plate. A very slight drop, however, increases the resistive unbalance of the bridge and thus provides enough grid excitation to supply the load current. It follows that within the power limitations of the tube, the voltage amplitude at the plate is practically independent of the load. For similar reasons, it is quite independent also of changes in the battery supply voltage and of the emission so long as these qualities are adequate to supply the required output without tube overloading.

TRANSFER AND ALARM FEATURES RM. 9-4

There are alarms provided to give audible and visual signals in case of trouble and for certain types of troubles the load on the oscillator group in trouble is transferred automatically to the other oscillator group.

PLATE AND FILAMENT BATTERY ALARM

The total space current for the six tubes of one oscillator group is sufficient to maintain the PL relay in an operated condition, but is insufficient to operate the PL-1 relay. Failure of the 115 volt plate and screen grid battery supply or failure of the filament battery supply causes the release of the PL relay which connects ground to the P1 or P2 lead of its associated Fig. 3 to operate the alarm and transfer circuit as described later.

In case the F-1 or F-2 condenser becomes short-circuited connecting the 115-volt battery plate supply into the cathode battery supply, the marginal PL-1 relay operates on the difference of potential between these two batteries.

This condition would stop all tubes in the oscillator group from conducting because of positive potential on the cathodes. The operation of the PL-1 relay for the odd oscillator connects ground to the P1 lead, while the operation of the PL-1 for the even oscillator connects ground to the P2 lead. Either lead being grounded causes the operation of the alarm and transfer circuit as described later.

OSCILLATOR VOLTAGE ALARM

Each oscillator group is connected to a voltage alarm circuit in Fig. 3, the connection being made on the load side of the transfer relays in Fig. 2. The output of each frequency oscillator in the group is connected to one of the rectifier elements in a double rectifier unit. The output of each rectifier in the pair is connected across a resistance in opposing direction to the winding of a sensitrol relay having a zero center adjustment with no current flowing. As long as the voltage from both oscillators in a pair is equal, no current flows in the sensitrol relay.

This double rectifier unit is composed of four elements and is called a varistor. This varistor is a copper oxide rectifier which converts the alternating currents coming from the oscillator over the T and R leads to direct current. The copper-oxide element consists of a copper disc upon which has been formed a layer of copper oxide. This combination offers a low resistance to current flowing from the copper oxide to the copper, but a high resistance to current flowing from the copper to the copper oxide. Thus it becomes a "valve" to pass current in one direction only. A good electrical contact to the copper oxide is secured by using next to it a soft lead washer. The assembly is held firmly together by means of heavy pressure plates secured by a bolt and nut with washers at either end.

The convention for a single copper-oxide element is an arrow connected to a short horizontal line. The arrow is the copper-oxide side of the element and indicates the direction in which it will pass current. The horizontal line is the copper side and blocks the current when flowing in the direction to its side of the element.

Now let us consider for example the 700 and 900 cycle frequency combination. The 700 frequency is connected to the #3 and #4 terminals for its rectification. The ac frequency is applying current first in one direction and then in the other direction. The rectifier rectifies each half cycle causing a dc current to be applied to the resistance between the positive (+) point of the rectifier and terminal #6. The current in this resistance will always be in the same direction. Likewise, the 900 cycle frequency is connected to the #1 and #2 terminals and a dc value is applied to the resistance between the positive (+) point of this rectifier and terminal #5. Therefore, at each of the terminals #5 and #6, a voltage exists and each have a current in the opposite direction. As long as the voltage potential between these two points is equal, no current will flow through the winding of the sensitrol relay.

The normal variation in the output voltage in any oscillator is approximately + or -.5 db neglecting variations due to temperature changes, inasmuch as the temperature changes affect all oscillators in the group in the same manner.

Accordingly, one oscillator output of the pair may be .5 db above normal and the other .5 db below normal. With this condition, the sensitrol relay in cinjunction with the rectifier and resistance untis are designed to nonoperate on a difference of 1 db between the two oscillator outputs. The relay is adjusted to operate on an additional variation of .5 db up or down down·from either oscillator. In other words, only if there is a difference of 1.5 db between the frequencies of the two oscillators will the voltage snesitrol relay operate.

The most probable cases of trouble in an oscillator should reduce its output. However, if the circuit associated with the varistor VR- in the oscillator circuit should go opened, or if the varistor should change to a higher resistance value, the output voltage would increase. For this reason, the alarm circuit is designed to operate at high as well as on low voltage variations. The alarm circuit will not function if the output voltage of two paired oscillators increase or decrease proportionately together. Simultaneous increases are probable except in the case of uniform aging of two VR- varistors. This would occur at a slow enough rate to permit the output variations to be discovered on periodic routine tests on the oscillators before the increase voltage became objectionable.

The probable cause of simultaneous decrease in the output voltage of the two oscillators is failure of the plate battery or failure of the heater circuit of the two tubes or failure of the cathode battery. While anyone of the three conditions affect the space current and which is already covered by an alarm, the failure of the heater circuit would cause the operation of all sensitrol relays. This is because the arrangement of the oscillator tubes for the filament supply is different from the pairing of the oscillator output to the voltage rectifiers.

Should a sensitrol relay operate in the group associated with the odd oscillator, the HL1 lead is grounded, while if one should operate in the group associated with theeven oscillator, the HL2 lead is grounded. Either lead being grounded causes the alarm and transfer circuit to function as described later.

The contacts #4 and #5 of the sensitrol relays are provided with small permanent magnets so that when a contact closes it remains closed until reset mnaually. This feature insures that the alarm will be locked in should a swinging condition occur. Each contact is adjustable by a small metal know which appears on the face of the relay. In addition to the contact arm, the know has a red index pointer associated for setting. Resetting is accomplished by using one of the small metal knobs to back the contact away from the armature (#1) by moving the index to the red line appearing at the stop pins. When the armature hits the stop pin, the magnetic connection of the contact arm is broken, permitting the armature to restore to its normal zero center position.

The exact variation in the oscillator voltages to cause an alarm is subject to some adjustment by moving the contacts of the sensitrol relay farther apart or closer together. They should be adjusted as close as possible without unnecessary alarms.

AUTOMATIC TRANSFER AND MAJOR ALARM

Any trouble which causes a change in the output voltage of one of the oscillators in the odd group and is of sufficient magnitude to operate the sensitrol relay, it connects ground to lead HL1. A similar trouble in the even oscillator grou connects ground to the HL2 lead. Also, any trouble which causes the release of the PL relay or the operation of the Pl-1 relay for either the odd oscillator or the even oscillator causes the Pl or P2 lead, respectively, to be grounded.

Assuming that a trouble develops in the odd oscillator connecting ground to the HL1 lead, the following occurs:

Transfer circuit TO relay operates and the VO lamp lights, in parallel.

> Due to ground being connected to the HL1 lead.
> Both windings of BO relay are short is short circuited.

Transfer circuit TO-1 and TO-2 relays operate in series.

Transfer circuit TO-3 and TO-4 relays operate in series.

> The operation of the TO-1, TO-2, TO-3, and TO-4 relays transfers the load for all odd numbered key pulsing "A" positions to the even oscillator. All positions, both even and odd, are now being supplied by the even oscillator.

The TO (White) lamp lights.

> The lighting of the TO lamp indicates that the odd positions are transferred to even oscillator.

Transfer circuit ALM relay operates.

> Ground is connected to the R and DL leads to the audible and visual alarm circuit.
>
> Ground is connected to the D lead to the floor alarm frame.
>
> Ground is connected to the A and MJ leads to the audible alarm and pilot lamp circuit.
>
> The above leads, in being grounded, cause a major alarm.
>
> Should trouble develop in the even oscillator, ground will be connected to the HL2 lead causing an automatic transfer of all even positions to the odd oscillator, as described in operations #1 to #3, except for this transfer the TE, TE-1 TE-2, TE-3, and TE-4 relays operate and the VE and TE lamps are lighted.

TO SILENCE MAJOR ALARM

The major alarm can be silenced by the operation of the SWO or SWE key. Assuming that the SWO key is operated, the following occurs:

Transfer circuit TO relay holds operated.

Transfer circuit SWO lamp lights.

Transfer circuit ALM relay releases.

Ground is disconnected from all alarm leads.

When the trouble in the odd oscillator group has been cleared, the contacts of the sensitrol relay or releays are restored manually, removing ground from the HL1 lead. If the SWO key is operated, it is restored, or if the SWO key is not operated than the removal of ground from the HL1 lead causes the following:

Transfer circuit TO relay releases.

Short circuit is removed from both windings of the BO relay.

The SWO lamp is extinguished.

The VO lamp is extinguished.

Transfer circuit TO-1 and TO-2 relays release in series.

Transfer circuit TO-3 and TO-4 relays release in series.

The TO lamp is extinguished.

The release of the TO-1, TO-2, TO-3, and TO-4 relays transfers the load fro the odd positions from the even oscillator to the odd oscillator.

CANCELLATION OF AUTOMATIC TRANSFER

If a voltage change occurs in the odd oscillator group of sufficient magnitude to ground the HL1 lead and cause an automatic transfer and if the trouble is on the load side of the contacts on the transfer relays, the transfer will take place as described above, operating the TO-1, TO-2, TO-3, and TO-4 relays. Immediately, however, one or more of the sensitrol relays in the even Fig. 3, associated with the even numbered positions, will operate because of the trouble being transferred with the load. This will cause ground to be connected to the HL2 lead, causing the following:

Transfer circuit LO relay operates and locks.

The LO lamp is lighted.

Transfer circuit CO relay operates.

Holding circuit is connected to the ALM relay.

The holding circuit connected to the ALM relay is necessary to maintain the audible alarm since it would otherwise be silenced by the release of the TO relay.

Transfer circuit TO relay releases.

The TO relay, in releasing, releases the TO-1, TO-2, TO-3, and TO-4 relays and extinguishes the TO lamp. This causes the load for the odd positions to be immediately transferred back to the odd oscillator.

If a trouble occurred on the load side of the even positions, a cancellation of automatic transfer will take place lighting the LE lamp.

When the "cancel automtic transfer alarm" is sounded, it can be silenced by the operation of the CO-ALM key. This will release the ALM relay and light the CO-ALM lamp.

Do not operate the SWO or the SWE key to silence the "cancel automatic transfer alarm" when the LO or LE lamp, respectively, is lighted. This would cause a transfer to be made again and the complete load for all positions to be put on one oscillator and at the same time, the trouble would affect this oscillator, the only one in service.

If a trouble occurs on the load side of relays TE-1, TE-2 or TE-3 associated with the even positions, immediately after the transfer is made, the HL1 lead becoming grounded operates the LE relay through the make contacts of the TE-4 relay. The LE lamp is lighted to indicate a cancelled automatic transfer in the even oscillator.

To release the LO or LE lamp after the trouble is cleared, first reset any sensitrol relay that is operated, then operate the CO-RLS key.

MANUAL TRANSFER

If it is necessary to transfer the load to either the odd oscillator or to the even oscillator, this one can be accomplished by the operation of the SWE or the SWO key, respectively. The SWO key operates the TO relay which cuases the transfer of the odd positions while the SWE key operates the TE relay to transfer the even positions. Momentary operation of the alarm when making a manual transfer may be prevented by operating the B-ALM key. This prevents the ground on the breack contacts of either the TO-4 or TE-4 relay from momentarily operating the ALM relay.

If the SWO key has been operated to affect a manual transfer and a trouble appears on the even oscillator group ground will appear on both the HL1 and HL2 leads because both Figs. 3 are connected in parallel anytime a transfer is made in Fig. 2. The ground on the HL1lead will be ineffective since the TO relay is already operated by the SWO key. But ground on the HL2 lead will operate the LO relay through the make contacts of the TO-4 relay and sound the mjor alarm. Similarly a ground on the HL1 lead, when the SWE key is operated, will operate relay LE and sound the alarm. Nevertheless, in either case, the manual transfer will remain in effect until the SWE or SWO key is resotred, after which the CO-RLS key must be operated to release the LO or LE relay.

If the SWO key is operated while the even numbered positions are transferred or if the SWE key is operated while the odd positions are transferred, the alarm sounds to indicate improper key operation.

TRANSFER CIRCUIT BATTERY ALARM

The BO and BE relays are provided for the purpose of guarding against a failure in the battery supply for the TO-1, TO-2, TO-3, TO-4, TE-1, TE-2, TE-3 and TE-4 relays. The primary and secondary windings of the BO and BE relays are differentially wound. The windings of the TO-1 and TO-2 relays are connected to the primary winding and the TO-3 and TO-4 relays to the secondary winding of the BO relay. Likewise the TE-1, TE-2, TE-3, and TE-4 are connected to the BE relay.

If the battery fuse A should fail or the continuity through the windings of TO-1 and TO-2 relays, resistance OA or the winding of relay BO is otherwise interrupted, the BO relay operates on its secondary winding. If the battery fuse B or the continuity through the secondary winding of relay BO is interrupted, the BO relay operates on its primary winding. Operation of the BO relay lights the B-OFF lamp and operate the ALM relay for the major alarm. Operation of the BE relay performs the same functions. The alarm may be silenced while the trouble is being cleared by the operation of the B-ALM key. This releases the ALM relay and lights the B-ALM lamp.

If the battery A fuse fails while relay TO is operated, the TO and transfer relays TO-1, TO-2, TO-3, and TO-4 will release because the TO relay battery is on the same fuse. As soon as relay TO releases, the BO relay will operate on its secondary winding and give the alarm.

If the battery B fuse fails while relay TO is operated, the BO relay cannot operate because its primary winding is short-circuited. When the TO-4 relay releases because of this failure, it closes a ground through the make contacts of the TO relay to operate the ALM relay and give the alarm.

Similarly, failure of either the battery C fuse of D fuse associated with the TE, TE-1, TE-2, TE-3, and TE-4 will cause the operation of the BE relay to bring in an alarm.

OUTPUT LEADS GROUND ALARM

Each oscillator group has connected to the six output transformers, on the #3 terminal of the secondary coils, a relay for guarding against any load lead that may become grounded. For the odd oscillator group the GO relay of Fig. 8 is used and the GE relay for the even oscillator group. Ground on any of the associated output conductors through a resistance of not more than approximately 3,300 ohms causes the operation of relay GO or GE.

The operation of either the GO or GE relay lights the GO or GE lamp, respectively, and grounds the G lead to the transfer circuit to operate the ALM relay and sound the major alarm. The alarm may be silenced by the operation of the G-ALM key, which lights the G-ALM lamp and causes a buzzer to function. The buzzer will operate as long as the ground is present and will aid in the location of the grounded condition. The buzzer may be silenced by the operation of the BUZ key.

SUMMARY OF LAMP CONDITIONS IN TRANSFER CIRCUIT

LAMP	CONDITION
VO	Voltage failure on oadd oscillator.
VE	Voltage failure on even oscillator.
TO	Odd positions transferred to even oscillator.
TE	Even positions transferred to odd oscillator.
SWO	Manual transfer of odd positions to the even oscillator or SWO key if off-normal after an automatic transfer to silence the alarm.
SWE	Manual transfer of even positions to the odd oscillator or SWE key os off-normal after an automatic transfer to silence the alarm.
LO	Load side trouble on odd positions.
LE	Load side trouble on even positions.
GO	Grounded output lead associated with odd oscillator and odd positions.
GE	Grounded output lead associated with even oscillator and even positions.
CO-ALM	Visual indication that the cancel transfer alarms was sounded and silenced. CO-ALM key in off-normal position.
B-OFF	Indicates failure of battery supply for transfer relays or failure of their operating continuity.
B-ALM	Visual indication that the battery supply alarm for transfer relays was sounded and silenced. B-ALM key in off-normal position.
G-ALM	Visual indication that output lead ground alarm was sounded and silenced. G-ALM key in off-normal position.

DISTRIBUTING RESISTANCES RM 701 AND 9-4

To prevent individual circuit troubles from affecting the supply for the complete load, distributing resistances are provided at the supply equipment in each of the leads to the switchboard keyset. A group of resistances as shown in Fig. 11 are carried to the positions in a separate cable and distributed to the positions to be served as shown in the typical arrangement of Fig. 104. At shown in RM 9-4 , two Figs. 11 are required for each 4 switchboard positions.

For switchboard positions having a combination of M-F and D-C key pulsing operation, the paired supply leads from the distributing resistances are cabled directly to the switching relays at the miscellaneous relay rack. From the miscellaneous relay rack to the switchboard position, paired conductors are used for each frequency, one conductor of each pair being used or dead ended in the position. This provides a marked reduction in the disturbing effects of these distributing leads in the idle (nonsignaling) condition.

It will be recalled that a multifrequency signal consists of two frequencies being sent simultaneously, each frequency must have a point of termination. RM. 9-3 illustrates what occurs when an operation at an "A" board position depresses a key, the two frequencies are connected, on to the #2 terminal and one to the #5 terminal of the A repeat coil in the key set circuit. When this connection is made only two of the T0, TL, T2, T4, T7 or T10 leads from the output transformer are being actually connected to the repeat coil in the key set circuit. This is mentioned for the purpose of realizing that the termination for each frequency is received through the other output transformer of the pair. This termination is provided for by the strapping which appears between the #3 terminals (part of the output leads ground alarm, Fig. 8) on each output transformer in the oscillator group.

For test circuits, separate cables are used to each test circuit location with distributing resistances as shown in Fig. 12 to secure the proper pairing up to the location of the test equipment. The unused leads are terminated at the test equipment.

One Fig. 12 is required for supplying the terminating sender test frame and the frequencies are cabled from the resistances to the test frame. One Fig. 12 is required for supplying the frequencies to the incoming trunk test wagon. For this test, the frequencies are cabled to the "test current supply control circuit," which consists of a relay group for connecting the frequencies momentarily. From this group of relays a looped cable run is made to all Jones jacks on the terminating trunk frames requiring multifrequency operation. The purpose of this arrangement is to prevent a cross or ground condition from interfering directly with the multi-frequency current supply circuit.

DISTRIBUTING JACKS

The jacks in Fig. 4 are connected directly across the output leads from the transfer and alarm circuit. Two sets of jacks are provided, one set for the leads supplying the even numbered positions and the other set for the leads supplying the odd numbered positions.

In case of severe damage to the apparatus of wiring of the alarm and transfer circuit, the even or odd 700 cycle to 1700 cycle jacks of Fig. 4 may be patched to the corresponding 700 cycle to 1700 cycle jacks of the associated oscillator group unit. The intervening wiring may then be disconnected at the terminal strips on the oscillator group unit or the transfer and alarm unit, and the load supplied directly over the patching cords while the damage is being repaired.

CHAPTER 9

SECTION 2

METHOD OF OPERATION

REGISTERING "BUSY LINE" FREQUENCY IN THE NO. 1 CROSSBAR SYSTEM

Terminating Marker Circuit SD-25283-01

MARCH 1954

METHOD OF OPERATIONS

Registering "Busy Line" Frequency in the No. 1 Crossbar System

If offices, stores, and other extensive users of the telephone are to have adequate service, they must have a sufficient number of lines to the central office to insure that incoming calls will not find the lines busy except at times of unusual load. Probably the most effective way of determining whether or not additional lines are needed is to record the number of times the lines are all found busy over some convenient period. This is determined at the central office which serves the subscriber, and apparatus for automatically counting the calls that fail to reach the subscriber because all lines are busy has long been in use in dial areas.

In step-by-step and panel system the only part of the switching equipment that knows whether or not a line is busy is the last switch in the chain: the connector in the step-by-step system and the final selector in the panel system. These are the switches that "busy test" the line and send a busy signal back to the calling subscriber. These final switches do not have a record of the called number, but are guided to it either by a sender in the calling office or by the dial of the calling subscriber. It has been necessary, therefore, to associate the circuit used for counting the all-lines-busy conditions with the actual line terminals, and to arrange the final switch to pass a signal to the counting circuit when an all-lines-busy condition is encountered. The registering equipment must be capable of being connected to any of the line terminals for which a count is to be made, and, whenever a study is to be made on a different line, the connection must be changed accordingly.

In the crossbar system the lines are tested by the terminating markers, and these markers also have a record of the number of the line called. By associating the counting circuit with the marker, therefore, of which there are only a comparatively few for each office, a much simpler system has been developed.

Chart 1 - Combination of Operated Register Relays to Give the Various Digits

Digits	Relays Operated in Either H, T or U Set	Relays Operated in Th Set
0	0	0
1	1	1
2	2	2
3	1 2	1 2
4	4	4
5	5	4 1
6	5 1	4 2
7	5 2	4 2 1
8	5 2 1	8
9	5 4	8 1

After the marker has encountered an all-lines-busy condition, it returns a signal to the incoming trunk circuit to record the fact, and this circuit returns the busy signal to the calling subscriber. The terminating markers are arranged so that during this short interval while they are signaling the incoming trunk circuit of the busy condition, they also connect to the line-overflow register circuit, and indicate to it the called number. This transfer of information takes place while the marker is continuing its normal function, and thus does not increase the marker holding time.

A record of the called line is stored on four sets of four relays in the terminating marker - one set for each digit of the number. The four relays of a set are operated or not operated in different combinations for each of the ten possible digits. Similar sets of register relays are also provided in the common equipment of the line overflow register circuit, and when a marker finds all the lines busy for a particular number recorded on its register relays, it operates the same combination of register relays in this common equipment. The various combinations are shown in Chart 1. Depending upon the particular combination of operated or not operated relays, ground will be placed on one or another of ten leads, and the lead grounded indicates the value of the digit recorded. The arrangement of one set of these register relays in the common equipment is shown in RM 9-5, Fig. 1. There is a similar set of ten leads from the other three sets of register relays. As a result of the operation of the register relays in the common equipment, the number called will be indicated by a ground appearing on four leads, one in each set of ten from the register relays.

Each marker will operate a combination of register relays in the common equipment every time an all-lines-busy condition is encountered, but only occasionally will this combination correspond to the line number for which the count is being made. The circuit must thus be arranged to operate the register only when the number recorded on the register relays of the common equipment corresponds to that on which a count is being made.

This is accomplished by carrying the four sets of ten leads from the common equipment to four sets of ten jacks - each set arranged as shown in Fig. 3. The "ring" terminals of all jacks in each set of ten are connected together and carried to a matching circuit used to operate the register, and plugs with their "ring" and "sleeve" terminals connected together are inserted in jacks of the four sets to correspond to the number for which the count is being made. Thus, for a count of line 6725, plugs would be inserted in the No. 6 jack of the thousands group, in the No. 7 jacks of the hundreds group, and so on. This connects these four leads to the matching circuit. Since in such traffic studies it may be desirable to observe several numbers at the same time, several matching circuits, each associated with four sets of ten jacks in the jack field, are also provided.

Each matching circuit consists of a set of four matching relays plus a relay to operate the register, as shown on RM 9-5, Fig. 3. Only when ground appears on all four of the leads, indicating that the number recorded on the register relays is the one being studied, is there a closed path to operate the ML relay, which in turn operates the register. For any number found busy but not being observed, one or more of the relays of each matching circuit will not be operated and thus the circuit to each ML relay will be open, and no register will operate. The registers are somewhat sluggish in operation, and the ML relays are arranged to lock operated through a contact on the register, to insure that the register is fully operated.

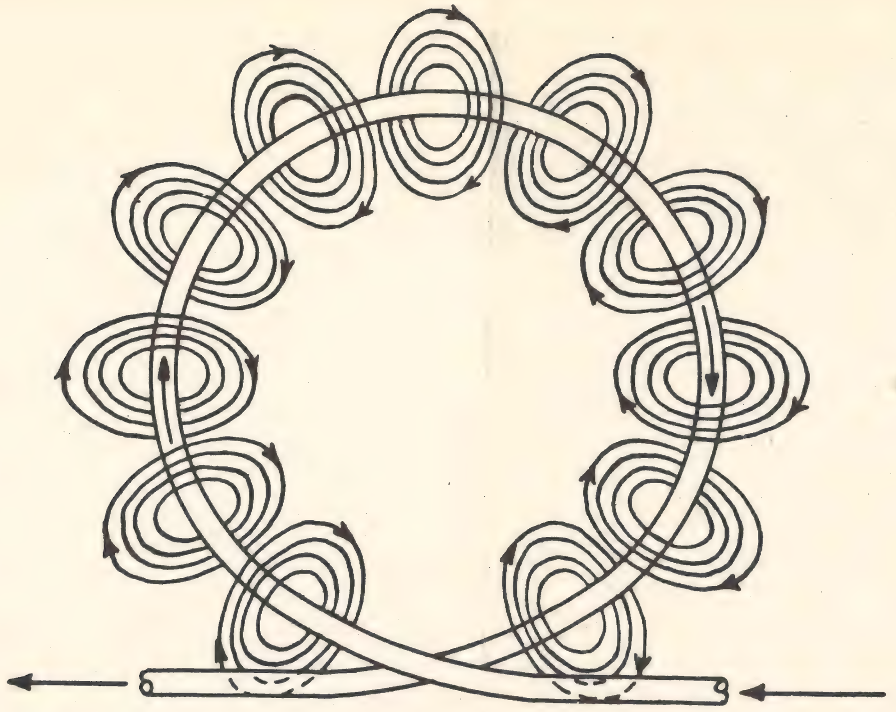
Markers are provided in groups of from 3 to 10, and each such group of markers may handle the calls for from one to four central offices. Moreover there may be several groups of markers in the same building. The line overflow register circuit was thus designed to record for as many as 30 markers. Since only one all-busy condition can be recorded at a time, the circuit by which the markers gain access to the register circuit is arranged to permit only one connection at a time. Should two markers encounter an all-busy condition simultaneously, only one would be connected through at that time and there may be insufficient time before the other marker releases to permit it to make a record of its busy number. Since the connection to the register circuit is maintained only for a very short time - a fraction of a second - and since an all-lines-busy condition is a comparatively rare occurence, the number of lost records because of this limitation is insignificant except under conditions of extreme overload.

Each marker gains access to the common equipment of the register circuit through a cut-in relay which connects the four leads from each of the four sets of register relays in the marker to the corresponding relays of the common equipment shown on RM 9-5, Fig. 1. The operation of these cut-in relays, however, is controlled through a lock-out circuit and a set of preference relays. This combination prevents more than one cut-in relay from being operated at the same time, and determines which marker should be connected through when more than one encounter an all-busy condition at the same time. Each marker has its preference relay, and is given a preference classification, and when two or more markers attempt to gain access to the register circuit at the same time, only the one with the highest preference is accepted.

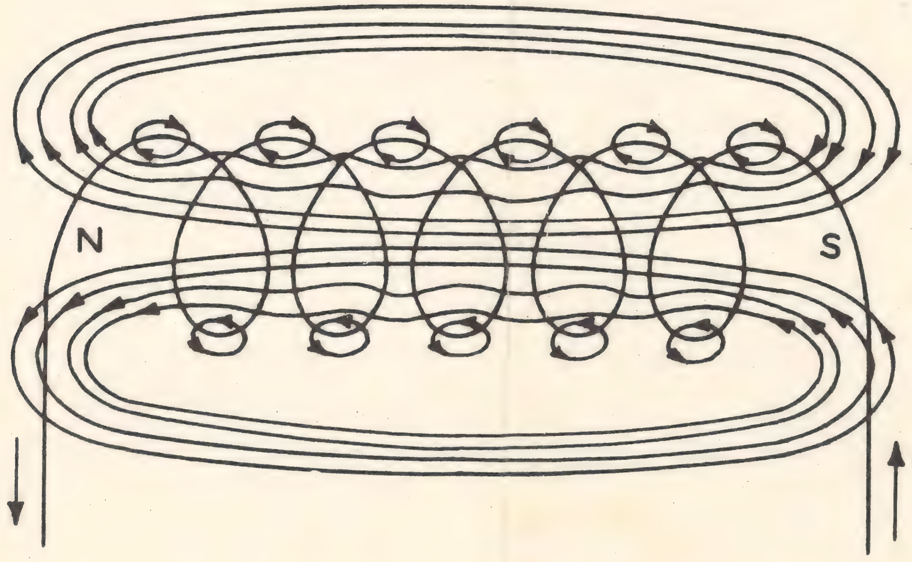
This arrangement is indicated on RM 9-6, which shows the entire system in block schematic form.

Since the various registers may be used for recording all-lines-busy conditions for lines in several office units, and since the same line numbers may appear in all of them, it is necessary to plug up for the office name as well as for the line number. Besides the numerical jacks in the jack field, therefore, a set of jacks is provided for each register to select the office desired. For each register circuit there is one of these jacks for each possible office, and a plug is inserted in the proper office jack as well as in each numerical jack. These office jacks extend the ground lead G of RM 9-5, Fig. 3 through to the markers, in a manner similar to that of the number jacks. Ground will appear on this lead only when the number involved is in that particular office.

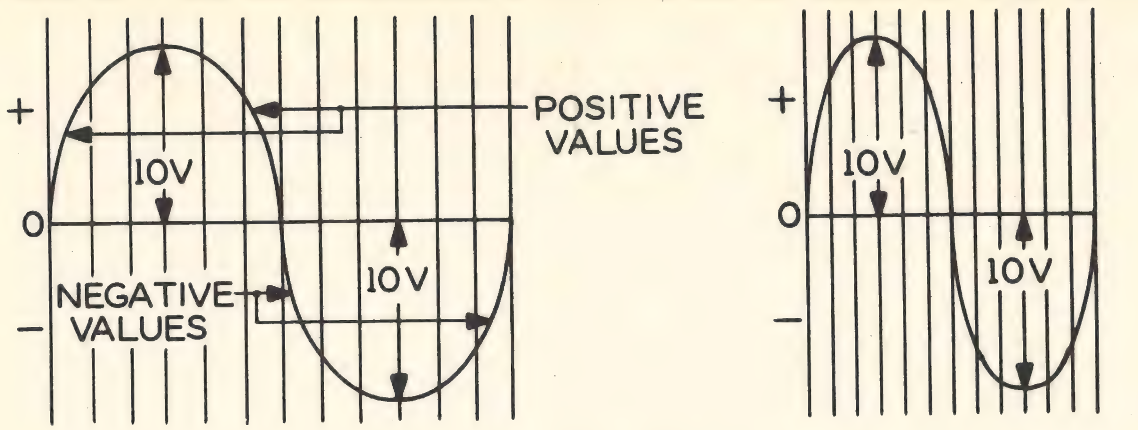
With such equipment it is a simple matter to secure a count on any line. It is necessary only to insert five plugs in the jack field of one of the registers, and to read the register at the beginning and end of any desired period. A change in the line being studied is readily made at any time. In the Murray Hill-2 office in New York City the jack field for the busy-line register circuit are installed in the lower part of the traffic register rack as shown in the photograph at the head of this article. The jack field is shown in greater detail in RM 9-7.



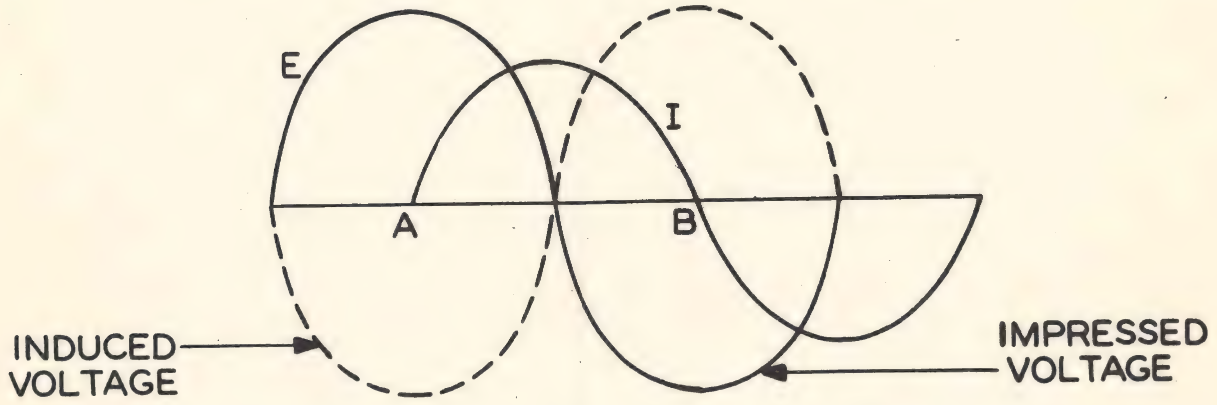
FIELD ABOUT A SINGLE LOOP CARRYING A CURRENT



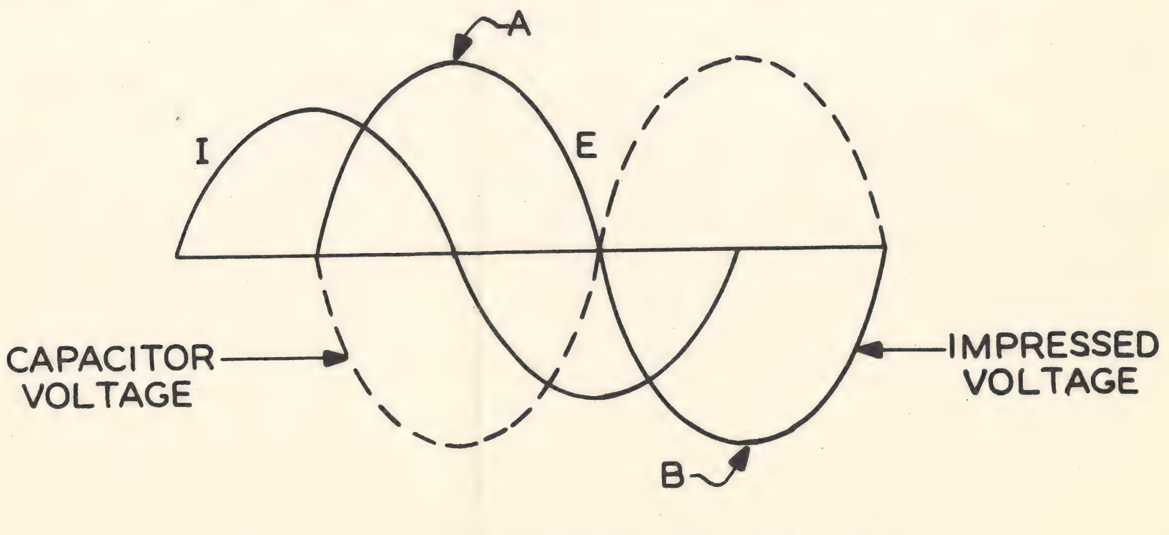
FIELD WITHIN AND WITHOUT A LOOSE COIL CARRYING A CURRENT



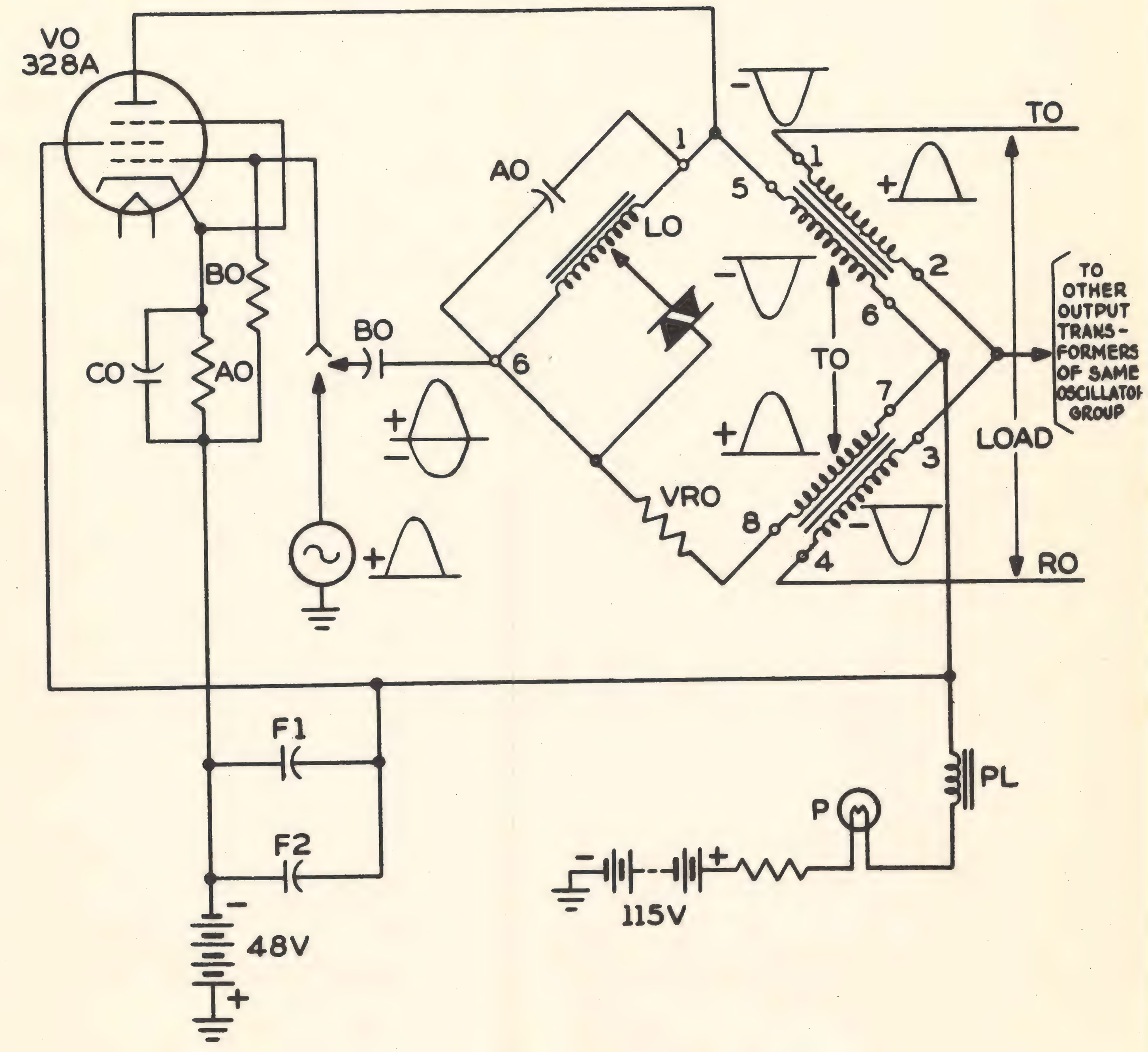
SINE WAVES OF DIFFERENT FREQUENCIES



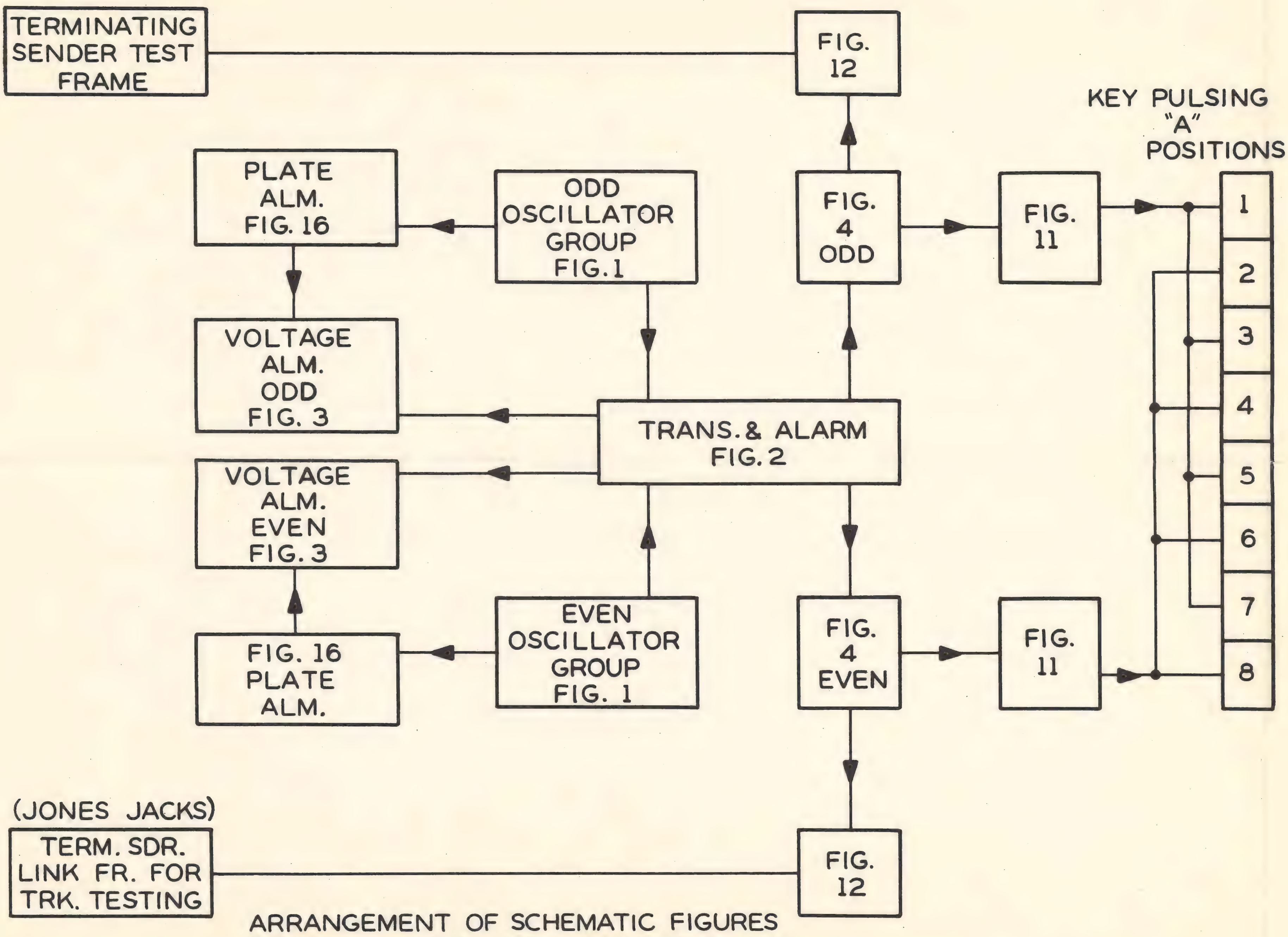
EFFECT OF INDUCTIVE REACTANCE



EFFECT OF CAPACITIVE REACTANCE



THEORY OF OSCILLATOR OPERATION



ARRANGEMENT OF SCHEMATIC FIGURES
OF MULTI-FREQUENCY CURRENT SUPPLY

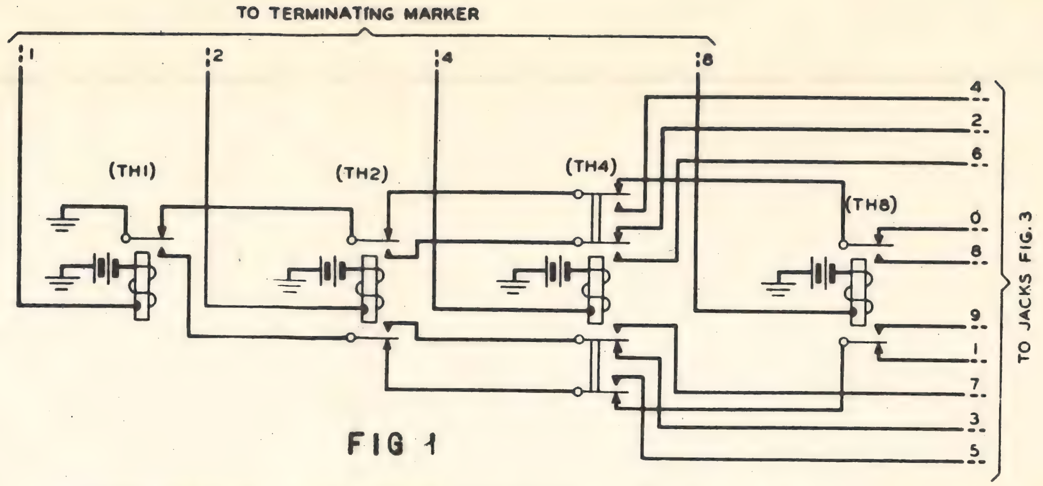


FIG 1

The register relays in the common equipment—four sets as above—translate signals over four leads from the marker to a ground on one of ten leads

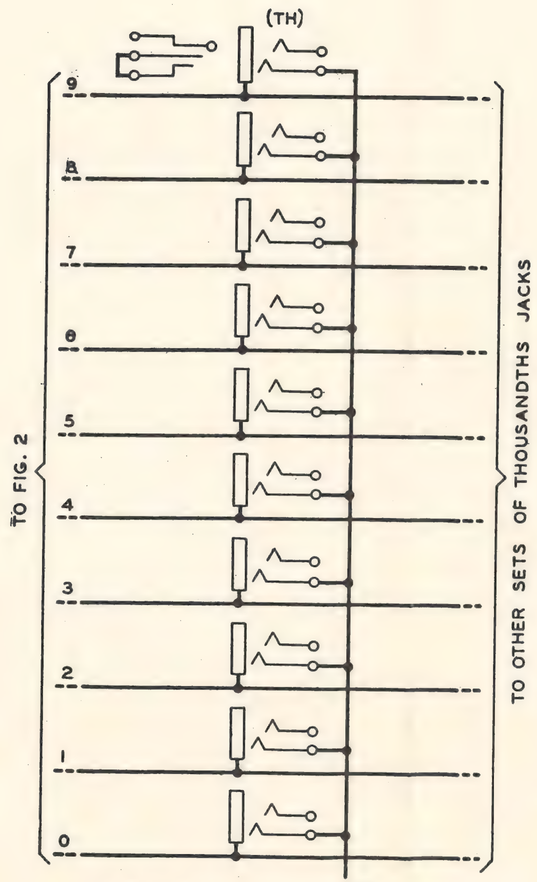


FIG 2

—For each digit of each register circuit a set of ten jacks is arranged as shown

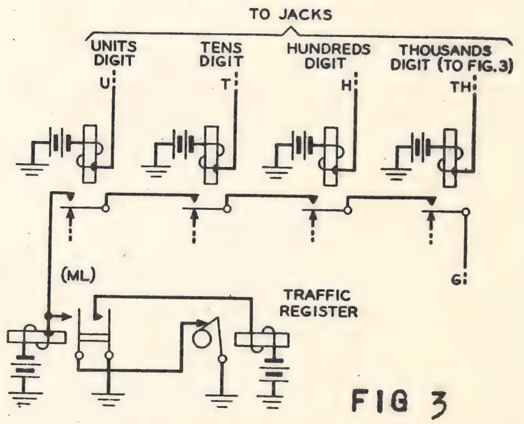
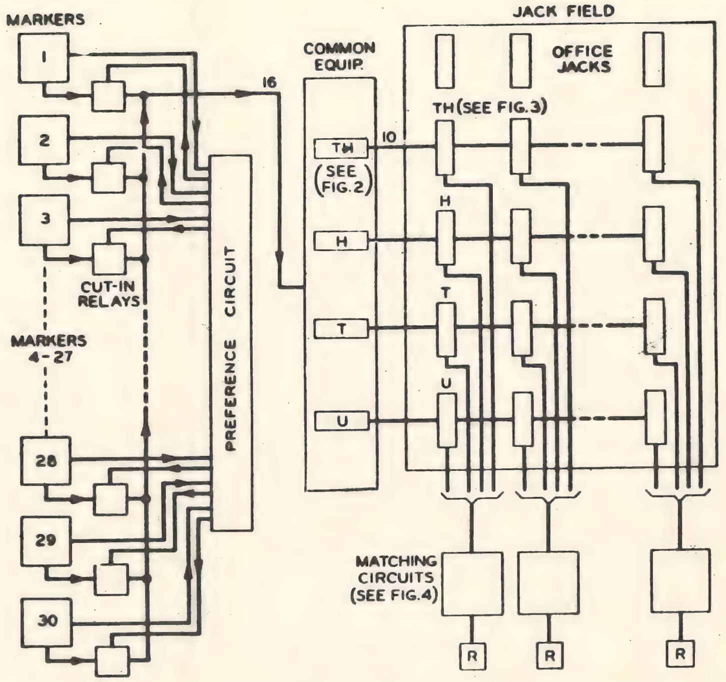
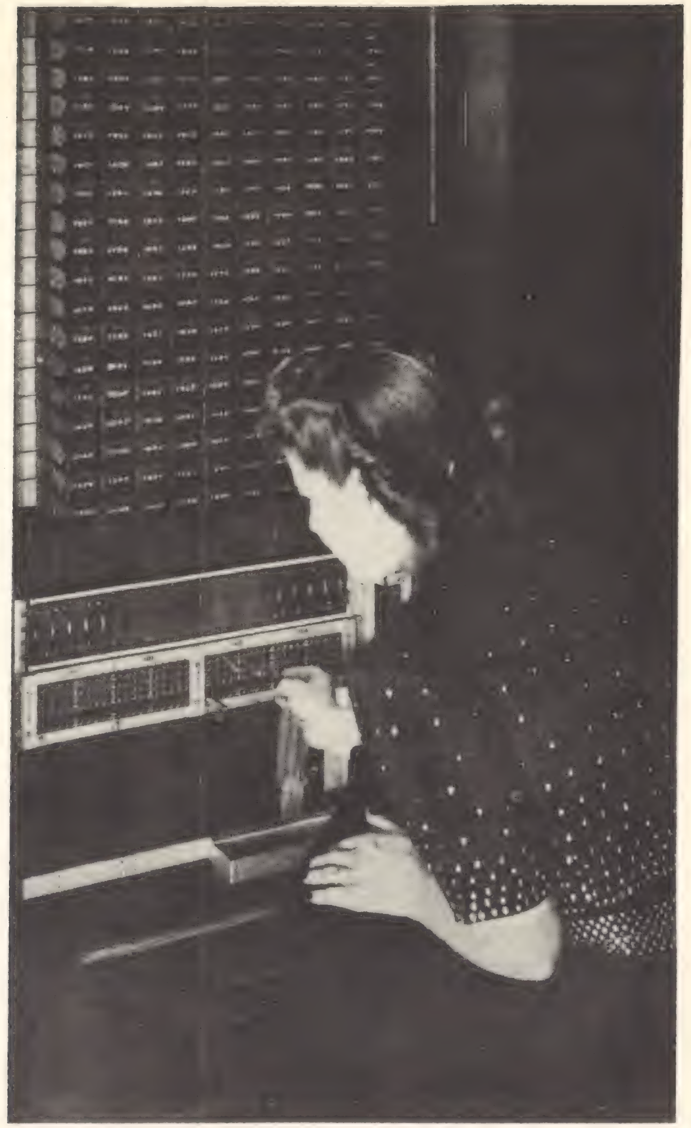


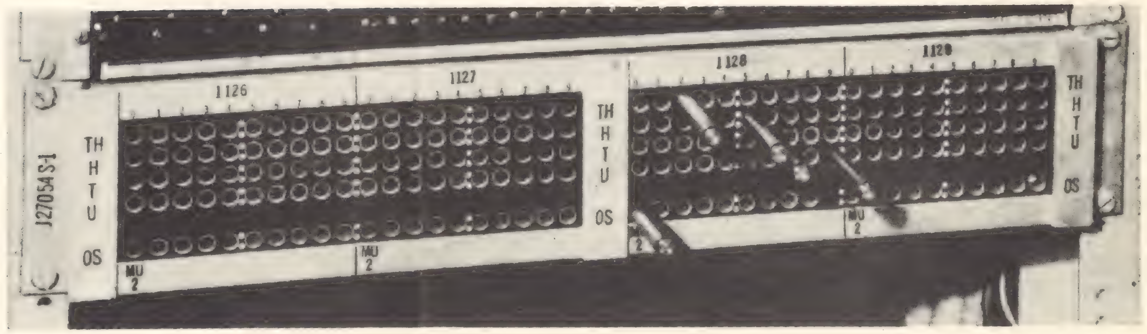
FIG 3

—Typical arrangement of matching relays in the common equipment



Block schematic for the all-lines-busy register circuit used in the crossbar system





Jack field for busy-line register circuit in the Murray Hill-2 office

CHAPTER 9

SECTION 3

TEST FRAMES

MARCH 1954

TEST FRAMES

ORIGINATING EQUIPMENT

The test frames associated with the originating equipment of a crossbar office are: District Junctor Test Frame; Originating Sender Test Frame; Sender Make Busy Frame; Outgoing Trunk Test Frame; Originating Trouble Indicator Frame and Controller Trouble Indicator Frame.

As the Test circuits are quite complicated, only a general description of the frames and their various test functions will be discussed in this chapter.

DISTRICT JUNCTOR TEST FRAME - RM 9-8

The district junctor test frame is arranged to test a maximum of 2000 subscribers district junctors (1000 of which may be coin districts) in one originating marker group.

The district junctor test frame is a single bay framework and contains a fuse panel, miscellaneous terminal strips, multicontact relays for connecting to junctor groups, operating apparatus (206 type selectors, relays, registers, timers, etc.) for various tests, key and lamp panel, and a writing shelf and ticket receptacle. The relays and other plate mounted apparatus are covered by a casing on the front only.

The group connecting relays on the frame cut a number of common leads through to a 100 point crossbar switch located on and furnished as part of the subscribers sender link frame. This crossbar switch serves as a connector switch to connect any of the 100 district junctors, associated with the subscribers sender link frame, to the test circuit. The 100 crosspoints of the switch are closed in rotation to test the junctors in routine, or any particular junctor may be selected for test by the control equipment. Each group of 10 district junctors will appear on one level of the switch. In cases of partially equipped district junctor units, the sleeves of crosspoints corresponding to the unequipped district junctor circuits are grounded to cause the test circuit to automatically pass by these positions. When a key pulsing junctor unit is located on a district junctor frame or if a unit is omitted on the district junctor frame, a cross connection at the test frame is made to cause the test circuit to skip the corresponding levels of the connector switch.

Key pulsing district junctors are not tested with the district junctor test frame. A box type test set is used for making any required tests on key pulsing junctors. Since an operator controls calls through key pulsing junctors the need for a mechanical means of routining the equipment, and identifying and locating trouble conditions is not necessary.

The district junctor test circuit is divided into several distinct parts according to the test functions each performs.

The connector control circuit starts the test frame, selects junctor groups or particular junctors, makes repeat tests if desired, advances the circuit upon completion of a test, passes or waits for a busy junctor, times out and indicates trouble, and performs several minor functions. By operation of a key in the test circuit a district junctor circuit is connected to the test circuit for test, and upon completion of the test on a particular district junctor, this circuit receives a signal to advance to the next district junctor to be tested. The testing of district junctors will progress automatically until all district junctors are tested.

The dial pulse circuit is used to generate dial pulses to prime the sender with a code when testing the junctor. Any combination of numerals for the three digits required for priming for four different classes of calls (free, charge, operator and zone) may be arranged by cross connection. A test code is assigned for each class and cross connections are made to register relays corresponding to the numerical digits assigned to each code. The relays send the dial pulses to the sender automatically to cause the sender to make connections through an originating marker to a test line over which the proper functioning of the junctor circuit may be checked.

The supervisory relay test circuit tests the supervisory relays in the district junctor for correct operation under extreme conditions, tests the transmission condensers for breakdown or opens, tests for correct operation on a "cut through" (operators class) call and tests for release on called party disconnect.

The charge testing circuit tests the tip or ring party charge in a 2-party district junctor, the length of the charging pulse, length of overtime interval, and overcharge or no-charge conditions. It also checks polarity, potential, and duration of coin current, and checks for various troubles such as stuck coin, no coin, etc.

The class circuit tests a junctor under various class conditions, and is used in conjunction with the charge test circuit. The following tests are selected manually by key; local charge, zone charge, condenser test, junctor disconnect, operator call, tip party charge, and automatic release.

Coin supervisory circuits may be tested from the district junctor test frame during light load periods. The test of coin supervisory circuits is semi-automatic and requires the attendance of a maintenance man at the test frame and the assistance of an operator at the "A" switchboard. Since there is a definite preference arrangement between coin district junctor groups and the coin supervisory sub-groups set up on the coin supervisory link frame, the maintenance man may, by means of records available in the particular office, determine for each coin supervisory circuit the number of the particular junctor or junctors which has this coin supervisory circuit as its first choice. By setting up a test call on this district junctor the features of the coin supervisory circuit may be tested. During regular tests of coin district junctors the coin supervisory circuits are selected on a random basis.

When coin district junctors are to be tested a talking circuit is furnished to provide a means of communication between the maintenance man at the test frame and the overtime monitor or coin supervisory operator at the "A" switchboard.

The test circuit may be controlled, on repeat tests, by remote control from jacks on the district junctor frames to enable the maintenance man to observe the particular district junctor circuit under test during a trouble condition.

The district junctor test frame is usually located near the district junctor frames.

ORIGINATING SENDER TEST FRAME - RM 9-9

The originating sender test frame is arranged for testing both subscribers and key pulsing senders and has a capacity of twenty subscribers and key pulsing sender sub-groups. This capacity may be increased to thirty sub-groups by means of an auxiliary originating sender test connector unit mounted on the sender test connector frame. A subscribers sender test sub-group consists of a maximum of ten senders and a key pulsing sender test sub-group consists of a maximum of five senders, which correspond to the link sub-groups.

The originating sender test frame is a two-bay single sided framework. It is arranged to mount all of the sender test equipment required for testing a maximum of twenty sub-groups of key pulsing and subscribers senders.

The left bay is equipped with all of the relays required for the testing of subscribers senders while the right bay is equipped with a key and lamp panel, a ticket receptacle and writing shelf, the relays associated with the testing of key pulsing senders and the relay type interrupter circuit. The connector equipment is located at the top of the frame to facilitate cabling. The relay type interrupter is located at the bottom of the frame to facilitate maintenance and to provide a location that is as free from vibration as it is possible to obtain. The relay equipment is enclosed by a casing on the front only.

The originating sender test circuit provides means for routine testing of subscribers and key pulsing senders on an automatic basis. Registration in the senders is made directly from the test circuit and the proper functioning of the senders is checked by the test circuit. When a test has been satisfactorily completed, the next sender is seized and tested. The test circuit continues to function automatically until a trouble is encountered. Repeat tests can be made in two ways, first, repeat tests can be made continuously on a particular sender or, second, two tests can be made on a sender, the test circuit is automatically advanced to the next sender and the two tests made, and so on until all senders under test have been tested twice. The test circuit is connected to the senders by means of crossbar switches, two of which may be mounted on the test frame and a third, when required, mounted on the auxiliary sender test connector unit. Each switch can connect to 10 sender sub-groups, each one having a maximum of 10 subscribers or 5 key pulsing senders. Each sender sub-group appears on a separate horizontal row or level on the crossbar switch. Connection to the circuit common to a sub-group of senders is obtained by means of a multicontact relay and a "U" type relay. A particular circuit may be singled out for test. An automatic pass busy feature is provided to pass by senders which are busy on service calls or have been made busy at the sender make busy frame. The sender being tested can be located by means of lamps which indicate the position of the sender on the crossbar connector switch. A major alarm is brought in when the test is stuck while testing common equipment for a sender sub-group. A minor alarm is brought in when the test is stuck while testing individual senders.

In assigning sender circuits to the connector switch levels, subscribers senders are ordinarily assigned first and then the key pulsing senders. In the event additional subscribers senders are furnished it is not necessary to re-locate the key pulsing senders as provision is made to continue the tests through a sender group even though senders of another group are located on intermediate levels of the connector switches.

The circuits used for the originating sender test frame are arranged so that, as far as practical, each separate function of the test circuit is in a separate circuit unit. There are 15 units in the test circuit.

The connector circuit controls the connection of the sender under test and determines the class of test to be made. This circuit is arranged to advance from a busy sender after a predetermined period of from 29 to 59 seconds, and also makes an audible test of dial tone and disconnect tone. An alarm is given if the test is not completed after a period of from 60 to 90 seconds after the start of the test. Registers are provided to record the number of circuits satisfactorily tested, the number of repeated single tests, and the number of busy senders which are passed without testing.

The code key and dial pulsing circuit generates the dial pulses for dialing into the subscribers senders and controls the code and number used for pulsing into the key pulsing senders. Provision is made to permit simulating maximum and minimum line, pulse speed, and percentage break conditions. Dial progress lamps indicate the position of the dial progress switches.

Route keys and revertive pulsing circuit is used to send revertive pulses to the sender and to check the number of pulses sent, to pass by office selections when not required, to test by means of slow revertive pulses, and to provide compensating resistances for the fundamental loop. Keys are provided for setting up and controlling the tests and lamps indicate the progress of the tests.

The full selector dial pulse control circuit controls the dialing of the code and number when testing full selector calls, tests the coin and register relays in the sender, tests for office selections, and tests the ability of the sender to control the district selectors.

The incoming and final selection control circuit tests the sender for incoming and final selections, simulates the functions of an incoming selector or an abandoned call, makes synchronizing tests and tests the (TG) and (TMG) sender relays for operate or non-operate. Keys are provided for setting up the tests and lamps indicate the particular test being made.

The PCI dial pulse control circuit controls the dialing of the code and number during the test of a panel call indicator class of call. It also tests the stations delay feature, coin features, office selections, and district control of the subscriber senders.

The PCI register circuit registers and checks the panel call indicator pulses from the sender. Keys are provided to set up the tests and lamps indicate the progress of the tests.

The overflow control circuit for subscriber senders controls the dialing and check of office and incoming selectors. It tests the sender overflow relay for speed of operation and for operation through high resistance.

The operator class control for subscriber senders tests the following operator class calls: zero operator, full selector calls to 3 digit operator, restricted code, blank code, and permanent signal.

The key pulsing circuit performs the functions of the "A" switchboard key set when testing key pulsing senders, and applies speed tests to the sender register relays.

The office selection control circuit for key pulsing senders performs the functions of the office selectors and checks the senders on released calls.

The overflow control circuit for key pulsing senders tests the senders for overflow conditions, imposes speed tests on the sender overflow relay and checks other minor sender functions.

Operators class control for key pulsing senders controls the testing of the routing of the call, simulates the conditions of trunk test corresponding to the type of trunk seized, and tests for minimum trunk test closure.

The sender group test circuit tests the group relays common to a sender subgroup. It tests for opens and crosses and operates the major alarm if tests are not completed in a specified time. Keys are provided for setting up and controlling the tests and lamps indicate the progress of the tests.

The code test circuit records and checks the information which the sender under test transmits to the originating marker.

The equipment for testing key pulsing senders is omitted when there are no key pulsing senders in the office, and certain apparatus used for testing coin senders is omitted when dial tone first coin senders are not furnished.

The receiver located on the key and lamp panel is used in making the audible test for dial tone or disconnect tone.

The preferred location for the originating sender test frame is in the maintenance center. RM 1-31, RM 1-32 and RM 1-33 show a typical arrangement of frames at the maintenance center.

SENDER MAKE BUSY FRAME - RM 9-10

The sender make busy frame provides a centralized location for busying out sender circuits for test purposes or trouble conditions. Certain register circuits are provided on the frame to record trouble conditions on the senders or their associated link frames.

There are three different types of sender make busy frames which may be provided.

The sender make busy frame for use in offices where subscribers senders are arranged for monitoring at the local "A" switchboard provides make busy jacks for subscriber and key pulsing senders, and for sub-groups of subscriber senders, key pulsing senders and coin supervisory circuits. Trouble registers are provided for controller circuits of the line link, subscribers sender link, key pulsing sender link and coin supervisory link frames. Stuck sender register circuits are provided to record the number of stuck sender conditions in each sender group. False start register circuits are provided for the controller circuits of the sender link and coin supervisory link frames.

The sender make busy frame for use in offices where the subscriber senders are arranged for timed release and where the permanent signal trunks, vacant code trunks, and coin supervisory circuits are terminated at the local "A" switchboard makes provision for the same equipment as indicated in the previous paragraph and in addition has provision for a partial dial register which is used only with timed release senders.

The sender make busy frame for use with timed release senders in an office without an "A" switchboard is provided with the same equipment as the frame used in offices with an "A" switchboard except that equipment associated with key pulsing senders is omitted. In addition, jacks and lamps associated with permanent signal, coin supervisory, coin vacant, coin station ringer test trunks, and coin test trunks to local test desk are located at the sender make busy frame. Test trunks from the local test desk and a test circuit are provided for use in testing subscriber lines on calls routed to permanent signal, coin vacant code, coin station ringer test trunks, and to coin test trunks to local test desk and for testing coin lines on calls which cannot be released by the coin supervisory controller circuits.

The sender make busy frames are a single bay framework. A sheet steel jack panel with two 8-1/2" panels accommodates the jacks, lamps, and keys for the various circuits. Associated equipment is mounted on an apparatus board and mounting plates. RM 9-3 shows a sender make busy frame for use in offices without an "A" switchboard.

The subscriber and key pulsing sender make busy jacks are used to remove a defective sender from service.

Group busy jacks are provided for subscriber and key pulsing senders and coin supervisory circuits so that all senders or coin supervisory circuits in a link sub-group can be made busy in the event that trouble develops in the sub-group or associated equipment.

A telephone circuit similar to that furnished on all maintenance desks and frames is provided on the sender make busy frame. Key ended trunk and tie line circuits are provided so that communication can be carried on with the various desks and switchboards in the office.

Space has been provided for mounting the trouble registers of the line controller, trouble and false start registers of the subscriber sender controller, the trouble and false start registers of the key pulsing sender controller and coin supervisory controller circuits and stuck sender registers for subscriber and key pulsing sender link groups. Link alarm lamps are also provided to indicate a trouble condition in the line link and controller circuits and subscriber sender link and controller circuits at a central point.

Since the functions of the sender make busy frame are closely associated with the originating sender frame, it is located adjacent to the test frame in the maintenance center.

OUTGOING TRUNK TEST FRAME - RM 9-12

The outgoing trunk test frame is used for testing trunks both outgoing and incoming in the crossbar offices and is therefore associated with both originating and terminating equipment.

The outgoing trunk test frame is composed of a test bay and one or two jack bays. RM 9-12 shows a test bay and one jack bay. When two jack bays are required, the general practice is to locate the test bay between the two jack bays. In some cases the telephone company may request that two test bays be furnished so that the routine test time required for testing the lines served by the outgoing trunk test frame will be materially reduced. The normal arrangement with the above condition is to locate the two jack bays together with a test bay adjacent to each.

The test bay is arranged to mount all of the equipment of the test cord circuits and associated circuits. The jack bay is arranged to mount the test and make busy jacks of the outgoing trunks which appear on the office link secondary switches and consists of two jack panels each having a capacity of 1,000 test and make busy jacks.

The number of jacks required at the jack bay will depend upon the number of office link frames in the office and the number of outgoing trunks each frame is arranged for. For an installation of 8 office link frames each of which are arranged for 200 outgoing trunks a total of 1,600 test and make busy jacks would be required. Since the capacity of each jack bay is 2,000 jacks, only one jack bay would be required. Connections to individual outgoing trunks are made by means of patching cords from the test and make busy jack to a test jack associated with the test circuit of the test bay and located in small vertical mountings in the jack bay jack panel casing. When test and make busy jacks are required for recording completing and special service trunks, these jacks are located in the jack panel in any available space not used for the regular test and make busy jacks of the outgoing trunks. These miscellaneous circuits require an individual test and a make busy jack and are cabled to the main distributing frame.

One test and make busy jack is required for each trunk outgoing from the office link secondary switches. These jacks are cabled direct to either the office link frame or to the main distributing frame. Economy of cabling is the controlling factor in the cabling arrangement. In arranging the jack panel equipment, space is assigned for 400 outgoing trunks per pair of office link frames in all cases and follow the marker test group assignments on the pair of office link frames. The 200 outgoing trunks in the left field comprise marker test group TL0, TL2, TL4, TL6, and TL8. The 200 in the right field comprise marker test groups TL1, TL3, TL5, TL7, and TL9 in the case of office link split levels and are equipped as required. These latter trunks comprise marker test groups TL10, TL11, TL12, TL13, and TL14 when associated with office extension frames. This arrangement eliminates the need for revision of the jack field in cases where split levels on office link frames are converted to non-split and extension frames are added.

The test bay, through the test jack on the jack bay, is used for testing and talking on all outgoing trunks terminating on jacks in the jack bay. Voltmeter tests can be made on these trunks, or test calls can be made to lines terminating in the same or distant offices. These calls may be through full mechanical equipment or a panel call indicator trunk positions, as the test circuit is arranged to perform all necessary originating sender functions.

In addition to testing the outgoing trunks, the test circuit is arranged to test incoming trunks from panel, tandem, toll, manual, and crossbar offices. Connection to these circuits is made over patching jacks located on the incoming trunk frames.

A subscriber line test circuit is available for the routine testing of subscribers lines. Voltmeter and insulation breakdown tests may be made as well as talking tests. Connection to the subscriber line to be tested is established through a special test incoming trunk used exclusively by the outgoing trunk test frame, and the call is completed to the desired line the same as any incoming call.

A telephone circuit equipped with a hand telephone set and an operators telephone set is provided on the test bay for talking on test calls, and over the key ended trunk and tie line circuits to the various desks and switchboards.

The test circuit is arranged to connect to a trunk or subscribers line without regard for a busy condition on the circuit. The various tests made from the outgoing trunk test frame are made on an automatic, semi-automatic or manual basis. Keys are provided for setting up and controlling the tests and lamps are used to indicate the progress of the tests.

The preferred location for the outgoing trunk test frame is in the maintenance center.

ORIGINATING TROUBLE INDICATOR FRAME - RM 9-13

The originating trouble indicator frame is a combined maintenance and test frame used to facilitate the location of troubles in and to check the operation of the originating markers. The frame is arranged to accommodate the equipment required to function with two originating marker groups of eight originating markers each.

The originating trouble indicator frame is a single bay framework and contains a fuse panel, miscellaneous terminal strips, control equipment (relays, registers, etc.) for the indicator and miscellaneous circuits, a key and lamp panel, and a writing shelf and ticket receptacle. The relays and other plate mounted apparatus, with the exception of registers, are covered by relay casings on the front only.

The trouble indicator circuit is arranged to take a record of the information set up in an originating marker when it fails to complete its functions in the allowed time. When the marker encounters a trouble condition which prevents it from fulfilling its functions, it summons the originating trouble indicator circuit to take a record of the various items of information which have been set up by the originating marker, district link and originating marker connector circuits. After taking the record the originating trouble indicator circuit signals the marker to transmit a trouble release signal to the associated sender, return to normal, and disconnect itself from the trouble indicator circuit. An audible alarm is sounded to summon a test man when a record has been taken from an originating marker.

While taking or holding a record from one originating marker, the trouble indicator circuit makes itself busy to all others and, after recording the frame number of the markers which summon it during the time it is busy, signals them to transmit a trouble release signal to their associated sender and return to normal.

The various items of information are recorded on relays and are displayed as lamp indications under control of a key. A record is held by the trouble indicator circuit until the release key is operated after which it returns to normal and is then available for selection by another originating marker.

The trouble indicator circuit, in addition to taking records of service calls when summoned by an originating marker, is provided with means for originating test calls and recording the progress of the calls through the originating marker circuit.

A set of keys is provided for setting the code, class of service and district frame information for all classes of calls that may be handled by the originating marker circuits in regular service. In addition, there are other keys for simulating trouble conditions which may be encountered by a marker. The indicating lamps, under control of a lamp key, indicate the progress of the test call.

As a secondary function, the originating trouble indicator frame serves as a location for apparatus to record several items of information not directly associated with the functioning of the originating marker circuits.

Originating marker, originating marker connector, district link and office link frames, busy indicating lamps, and connector sender position lamps are located on the originating trouble indicator frame. Make busy jacks are also provided for making originating markers busy to all originating marker connectors, originating markers busy to particular originating marker connectors, the trouble indicator frame busy to originating markers and for taking senders associated with the same originating marker connector out of service.

The control keys, guard and alarm lamps for equipment used for traffic overload control of both originating and terminating senders, are located on the originating trouble indicator frame because of its central location in the maintenance center.

Although the originating trouble indicator frame is not in the path of a service call, it is one of the most important frames in the crossbar office due to its primary purpose of facilitating the location of trouble conditions in the originating marker circuits.

CONTROLLER TROUBLE INDICATOR FRAME

The controller trouble indicator frame is similar to the originating trouble indicator frame. However, only 8 terminal strips are provided at the top of the frame which permits 20 mounting plates to be mounted under the top casing. The arrangement of the equipment in the key and lamp panel is also different.

The principal functions of the CTI frame are to facilitate the location of trouble in the subscribers sender link controllers; to indicate alarm conditions on subscribers sender link and line link controllers; to indicate that the emergency controller is being used by a particular sender link frame; when dialing districts are used, to indicate waiting calls on any dialing district group.

TERMINATING EQUIPMENT

The test frames for maintaining the terminating equipment are: Incoming Trunk Test Frame; Terminating Sender Test Frame and Terminating Trouble Indicator Frame.

INCOMING TRUNK TEST FRAME

The incoming trunk test frame is arranged to automatically test the incoming trunks. Access to the trunks under test is obtained by means of a connector which is located on a separate frame known as the incoming trunk test connector frame. The test circuit, after checking a trunk, is automatically connected to the next and so on until a trouble is encountered which will stop the test circuit and bring in an alarm or until all the trunks have been tested. When desired, particular trunks may be selected for test and these tests repeated as many times as necessary to locate trouble.

This frame is arranged to test 4,000 incoming trunks arranged in 20 groups of 200 each, accessible through the office outgoing trunks.

TERMINATING SENDER TEST FRAME

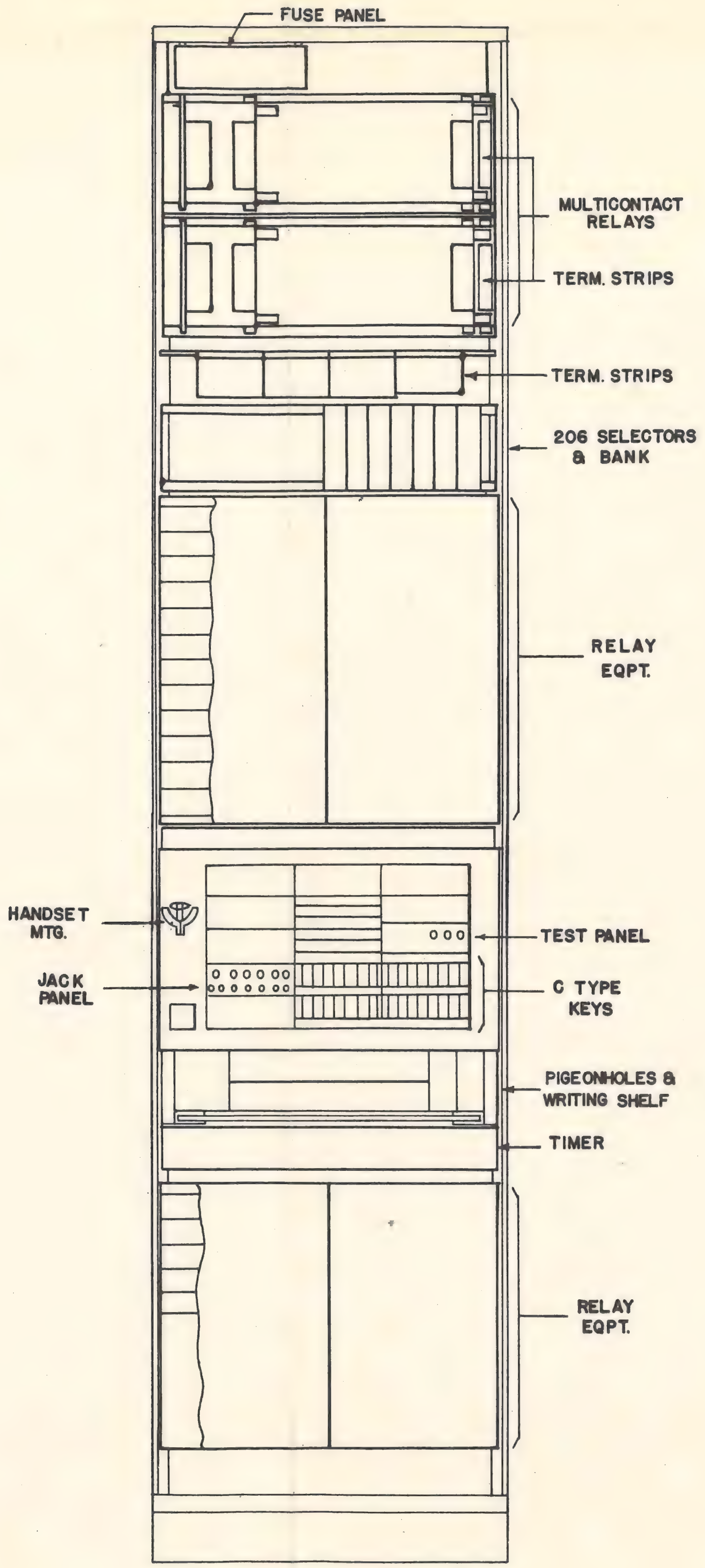
The terminating sender test frame is arranged to automatically test any of the 4 kinds of senders used with the terminating equipment. It makes connection to 20 "B" positions and 10 sub-groups of terminating senders. When the number of sub-groups of senders exceeds 10, an auxiliary terminating sender test connector unit is furnished which will accommodate 10 additional sub-groups of senders.

After testing a sender, the test circuit is automatically connected to the next sender until all the senders are tested. This automatic routine testing of the equipment to locate trouble condition is done in a similar manner as described for the incoming trunk test frame.

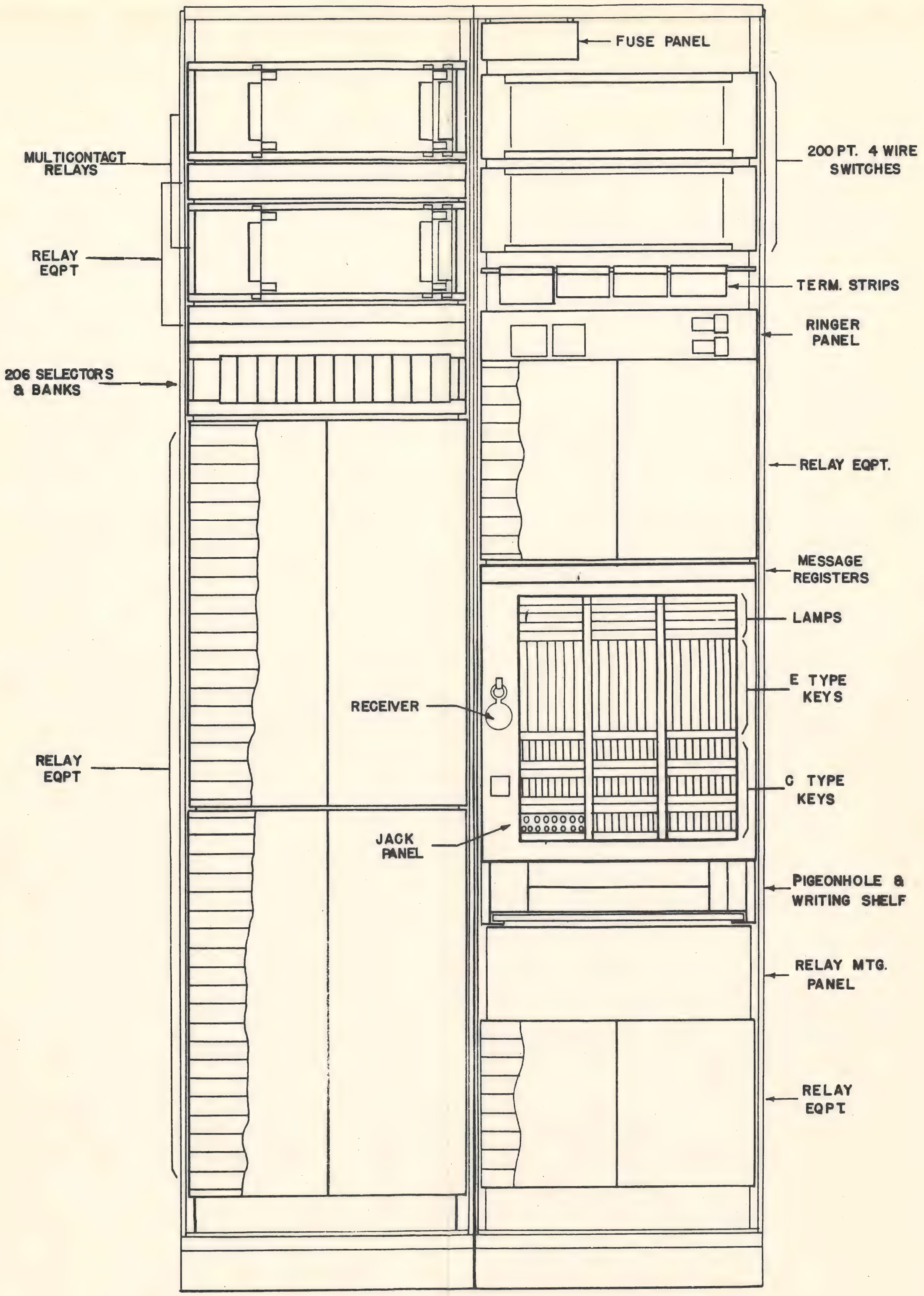
A terminating sender test frame is usually provided for testing terminating senders. An alternative method of testing the senders is to provide the test selection circuit for the outgoing trunk test frame, and sending test calls through the incoming trunks. The test selection unit is used to select the particular sender to be tested. With this arrangement the tests are limited to the detection of troubles already affecting service.

TERMINATING TROUBLE INDICATOR FRAME

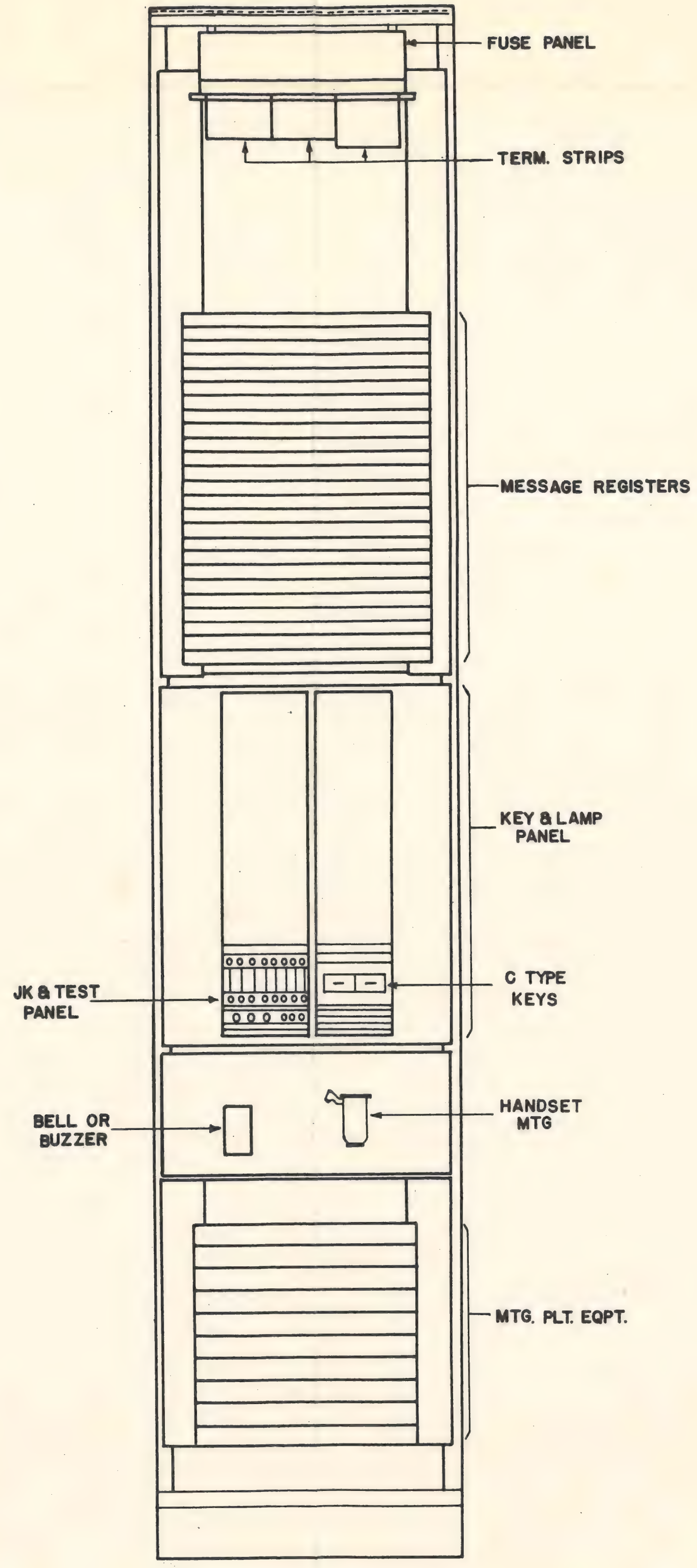
The terminating trouble indicator frame is a combined maintenance and test frame used to facilitate the location of troubles in and to check the operation of the terminating marker. It will take a record of the information set up in a terminating marker when it fails to complete its functions in the allowed time. It is capable of setting up a test call in a terminating marker, allowing it to complete its functions and then taking a record of the resulting translations and progress of the test call.



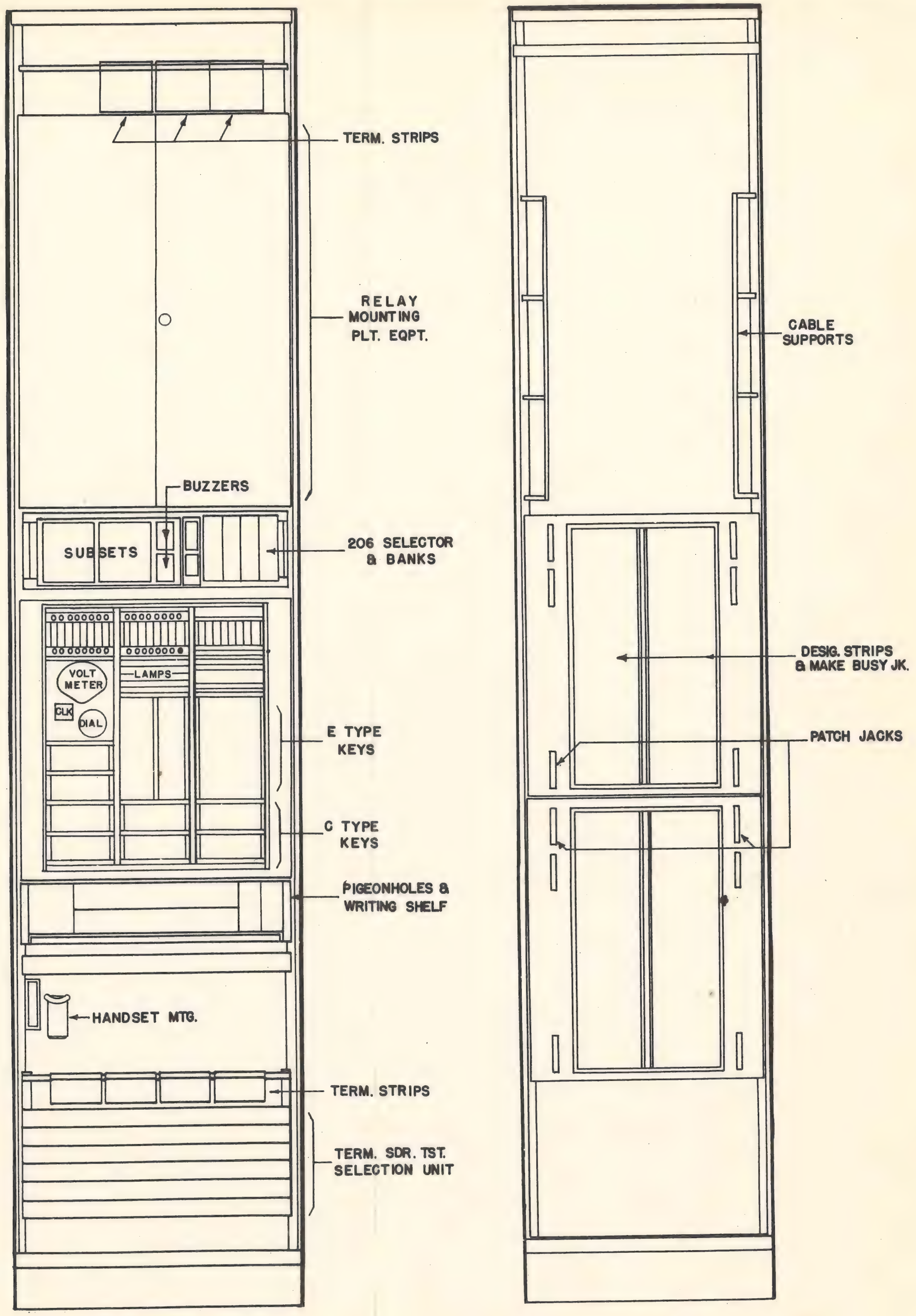
DISTRICT JUNCTOR TEST FRAME



ORIGINATING SENDER TEST FRAME



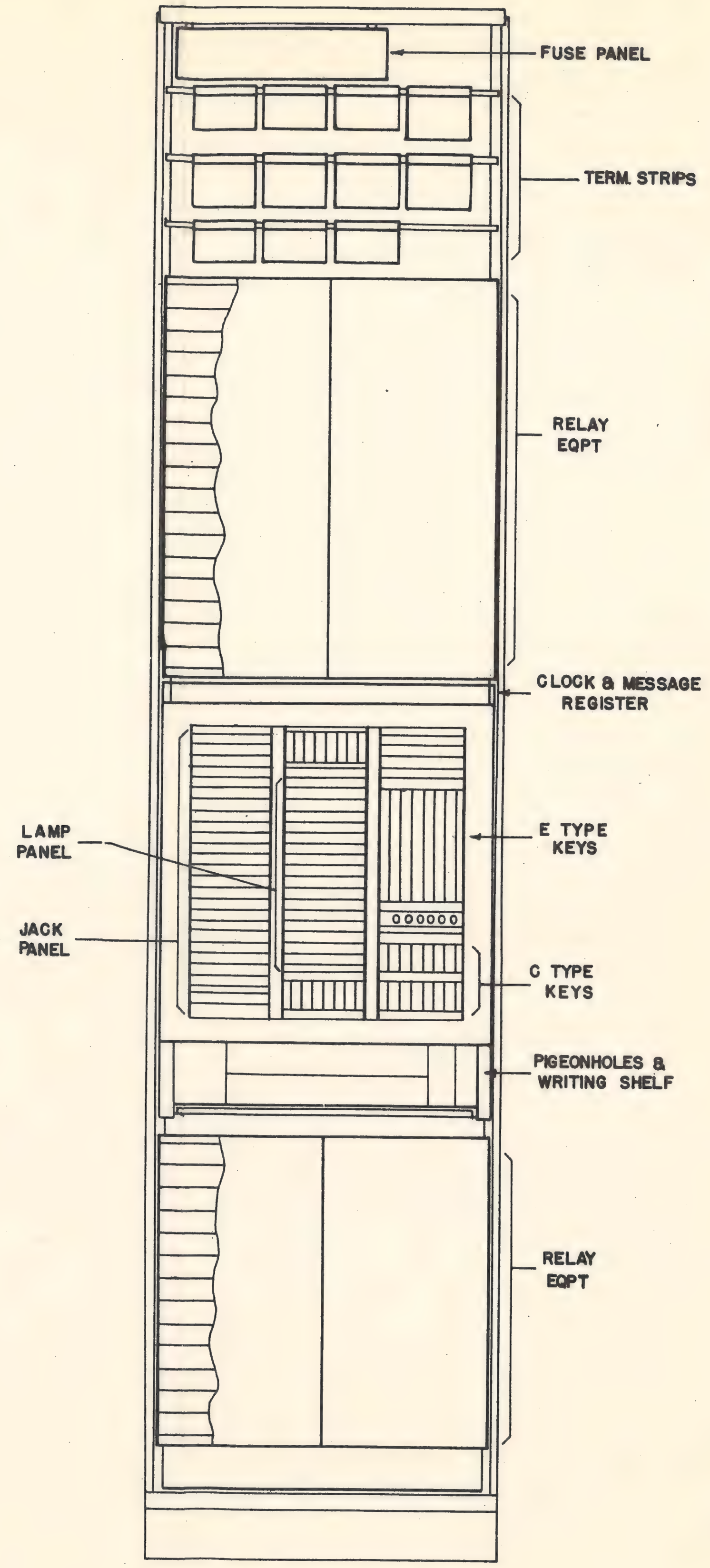
SENDER MAKE BUSY FRAME



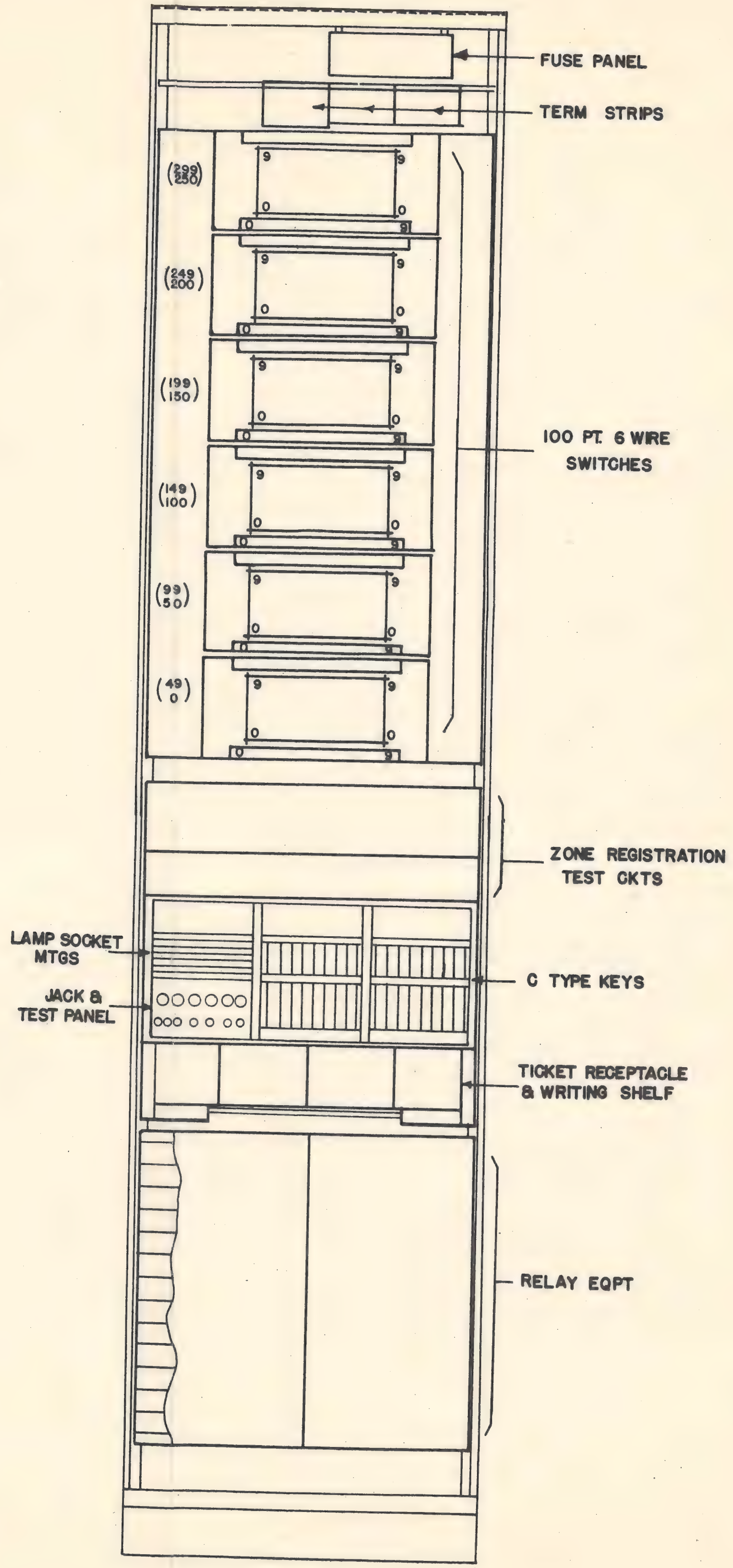
TEST BAY

JACK BAY

OUTGOING TRUNK TEST FRAMES



ORIGINATING TROUBLE INDICATOR FRAME



ZONE REGISTRATION TEST FRAME

CHAPTER 9

SECTION 4

TRAFFIC REGISTERS

MARCH 1954

TRAFFIC REGISTERS

This section will contain a description of the traffic registers and their association with the various types of equipment.

PEG COUNT REGISTERS

DISTRICT JUNCTOR PEG COUNT OS 601

When the originating marker has selected a channel, its (CHE) relay releases, which connects ground to the PC lead towards the district junctor.

Each district junctor frame has one PC lead per class of district. When the LC relay in the district link operates, the PC lead toward the register circuit is grounded causing the E relay to operate in turn operating the PC register associated with the particular class of district junctors on that frame.

OUTGOING TRUNK GROUP PEG COUNT OS 601

The originating marker route relay "PC" terminal is provided to furnish means for operating a register and thus record the number of originating calls routed to a particular trunk group.

> When a route relay operates and its associated ground supply (G-) relay is normal, the PC lead is grounded by the marker.
>
> The ground to the "PC" lead is opened at the contacts of the (DMT) operated so as to prevent false registrations on originating marker test calls. Likewise, the "PC" lead will not be grounded on sender test frame calls due to the (JD) relay remaining normal.

The E relay operates which in turn causes the peg count register associated with the outgoing trunk group to operate and score.

> On trunk groups that have two route relays, the "PC" terminal of only the first choice route relay (ground supply 1 or 3) should be cross-connected. The "PC" terminal of the second choice route relay (ground supply 2 or 4) should not be cross-connected because, if it were, the register associated with the trunk group would score twice when the first group of trunks were all busy and the marker operates the second route relay.

INCOMING TRUNK GROUP PEG COUNT OS 601

Toll or tandem incoming trunks have a peg count register associated with a group of twenty or less trunks. The operation of the (F) relay of any trunk connects ground to the "PC" lead and operates the E relay. This causes the peg count register associated with the incoming trunk group to operate and score.

INCOMING LINK FRAME PEG COUNT OS 601

When the terminating marker advances far enough to operate the (GT-1) relay, ground is placed on the PC lead to the incoming link and connector causing the E relay to operate which in turn causes the peg count register associated with the incoming link frame to operate and score.

NUMBER GROUP CONNECTOR PEG COUNT OS 601

When the terminating marker has progressed to the point where the (CON-1) relay operates, the PC lead to the number group connector is grounded causing the E relay to operate which in turn operates the peg count register associated with the number group connector.

ORIGINATING MARKER PEG COUNT OS 601

When an originating marker progresses to the marker stage, the (ST-4) relay operates grounding the MPC lead causing the L relay to operate which in turn operates the peg count register associated with the originating marker.

TERMINATING MARKER PEG COUNT OS 601

When the terminating marker has recorded the necessary information from the terminating sender, the (CK-4) relay operates grounding the PC lead causing the L relay to operate which in turn operates the peg count register associated with the terminating marker.

LINE LINK FRAME ORIGINATING PEG COUNT OS 601

Whenever a district junctor serves more than one class of service (such as individual and party), the peg count registration is made at the line link frame, if desired.

The DM lead of the line link frame originating the call will be grounded whether the call is being served by its home or mate controller.

When the MC-2 or HC-2 relay operates the DM lead is grounded causing the E relay to operate which in turn operates the peg count register associated with the line link frame.

LINE LINK FRAME TERMINATING PEG COUNT OS 601

When peg count register readings are to be recorded for a line link frame, the (LK) key associated with the particular line link frame is operated to the "line link frame" position.

On each terminating call to that line link frame, when the (CR) or (CE) relays operate in the line choice connector, ground is connected to the PC lead causing the E relay to operate. This causes the peg count register associated with the line link frame to operate and score.

HORIZONTAL LINE GROUP PEG COUNT OS 601

When peg count register readings are to be recorded for a line link frame or frames by horizontal groups, the associated "LK" keys are operated to the "horizontal line group" position.

Each terminating call to the line link frame or frames being recorded, when the (CR) or (CE) relay operate in the line choice connector, ground is connected to the PC lead through the operated (HG-) horizontal group relay causing the E relay to operate. This causes the peg count register associated with the horizontal group to operate and score.

"DSA" POSITION PEG COUNT OS 601

Each "DSA" board position is equipped with a "PC" key which the operator depresses momentarily to record the number of calls handled by her.

When the PC key is depressed ground is connected to the PC lead causing the E relay to operate. This causes the peg count register associated with the DSA position to operate and score.

CLOCK PEG COUNT OS 601

A clock peg count register is used by traffic to measure the elapsed time during traffic studies. The register operates and releases in unison with the (C) relay which operates on each clock pulse.

TIME ANNOUNCEMENT TRUNK PEG COUNT OS 601

When the (SL) relay of a time announcement trunk operates, ground is connected to the GR lead causing the E relay to operate. This causes the peg count register associated with the time announcement trunk to operate and score.

LOAD REGISTERS

LINE LINK FRAME LOAD REGISTER OS 601

When assigning subscribers' lines to the line link frames, an attempt is made to distribute the load over all the various frames. However, due to the variation in subscribers' use, the load may become unbalanced.

It is estimated that the line links receive their maximum load at only a few periods of the year during abnormal traffic. It would be undesirable to rearrange subscribers' lines during abnormal traffic in case of overloaded line link frames; therefore, a circuit has been provided which will operate a register every time a terminating call to a line link frame which has a certain pre-determined load (line links busy) calculated to correspond to a heavy load during an abnormal period.

This circuit consists of the terminating marker (REG) relay and associated resistances. The (REG) relay is a polarized parallel wound relay which will operate for any number of busy line links that the marker encounters by cross-connecting terminals "REG-1" or "REG-2" to terminals "R-5", "R-6", or "R-7" as indicated by the chart on OS 601. The chart also shows the resistance combinations cut into the circuit for the maximum and minimum line link load conditions, which holds the (REG) relay normal or causes its operation.

For example, assume the register is required to operate if the marker encounters 7 or more line links busy on a line link frame. According to the chart, the "REG-1" punching will be cross-connected to the "R-5" punching.

If there are six or less line links busy (indicated by the associated (LL- relays being normal), the resistance, in series with both windings of the (REG) relay, will be equal, or the "P-1" winding will be the greater. Thus, the current flow through both windings will be equal or the "P-2" winding will be the greater, and, since the "P-2" winding current is in the non-operate condition, the (REG) relay remains normal.

With one or more additional links busy, the current flow through the "P-1" winding (operate direction) is increased, overcoming the opposition produced by the weaker "P-2" winding (non-operate direction) causing the (REG) relay to operate.

> It will be noted that the circuit, through the "P-1" winding, is closed after and opened before the circuit through the "P-2" winding. This prevents false operation of the register.

HORIZONTAL LINE GROUP LOAD REGISTER OS 601

The horizontal line group load register is identical to the line link frame load register except that the operation of the (REG) relay connects ground to the PL lead through the line choice connector and line link horizontal group relay operated to the register circuit. In this case, the "LK" key is operated to the "horizontal line group" position causing a register associated with the horizontal group to operate.

> The PL lead is grounded when the line link HG relay operates causing the operation of the E relay which in turn operates the LD register causing it to score.

SUBSCRIBER SENDER LOAD REGISTER OS 601

The subscriber sender load register is furnished to provide a means of recording the number of times a pre-determined number of sender subgroups is busy.

When a subscriber sender subgroup is busy, its (SGB) relay operates connecting resistance ground to the CG lead. The number of sender subgroups busy at one time determines the current flow through the primary winding of the (K) relay (operate direction). When the primary winding overcomes the opposition furnished by the secondary winding, the (K) relay operates.

> The optional wiring "A", "B", "D", "F", and "G" provides for registering wh one to six senders subgroups, respectively, in the sender group are busy and serves to vary the current flow through the secondary or biasing winding of the (K) relay.

The operation of the K relay causes the A relay to operate which in turn operates the LD register. The SSL and SW relays at the sender make busy frame and the AX and SP relays at the DSA board operate.

An LR lamp at the sender make busy frame and the LR and BY lamps at the DSA board are lighted.

An audible alarm is also sounded.

When a sender becomes idle in a busy subgroup, the subscriber sender line controller disconnects the associated resistances from the CG lead, thus decreasing the current flow in the primary winding of the (K) relay. The (K) relay will now operate to its normal position if the secondary winding opposition is the greater. Whenthe (K) relay releases, the (A) relay and "LD" register release, removing the operating ground to the (SSL) and (SW) relays; however, the sender make busy and "DSA" lamps and alarm remain operated until released by the momentary operation of their respective "Release" keys.

DELAY REGISTERS

DIAL TONE RELAY OS 601

When an originating call has been connected to its home or mate controller, ground is placed on the DM lead to start a register timing circuit. If this ground remains from 1-1/2 to 2 seconds, a register will score.

With the DM lead grounded the DL interrupter causes the W and Z relays to function. This causes the N and N-1 relays to operate followed by the operation of the M relay and the DL register which scores. The RL lead is grounded to the line link controller operating the RL relay.

> If the line link controller has not found an idle group of district junctors by the time the (M) relay is operated, the grounded DK lead causes the line link controller to release which releases the timing register circuit. If, however, the controller finds an idle group of district junctors before the (M) relay operates, the (DS) relay will operate removing ground from the DM lead restoring the timing register circuit to normal.

TERMINATING SENDER LINK DELAY REGISTER OS 601

When an incoming trunk is selected, it connects ground on its ST start lead to a (GST) relay which is associated with a group of ten incoming trunks. The operation of any one of the ten (GST) relays of the terminating sender link and controller circuit places a ground on the IG lead starting a timing traffic register circuit.

The timing register circuit is identical with the "dial tone delay" register timing circuit previously described. If the ground on the IG lead is not removed before the (M) relay operates, a register will score. However, the operation of the (M) relay does not cause the terminating sender link and controller circuit to release.

OVERFLOW REGISTERS

OFFICE OVERFLOW OS 601

When an originating marker has selected an office frame, which is indicated by the operation of an (O-) relay, all available channels between the district and office frames are tested until an idle one is found, or, if they are all busy, relay (CRL) is operated.

Relay (CRL) operated, grounds the OF leads, under control of the particular (O-) relay operated, to operate the overflow register associated with those frames. There will be one register per pair of office link frames.

INCOMING AND LINE LINK OVERFLOW OS 601

On a terminating call, the terminating marker tests all available channels between the incoming frame on which the incoming trunk is located and the line link frame which is serving the called line. If all of these channels are busy, relay (OF) of the terminating marker is operated.

Relay (OF) operated, grounds the OF lead through the operated (MCB) relay of the incoming link and connector circuit to operate the overflow register of that incoming frame. The (OF) relay also supplies ground through the (MCB), (CR), and (CE) relays in the line choice connector to operate the overflow register associated with the called line link frame half choice. There will be one register per incoming link frame and one per half choice since the line junctors are common to the two line link frames of a half choice.

The OF lead is opened to prevent false registrations if:

a. The (OFT) relay is operated due to the called number being the overflow test number.

b. The (TMB) relay is operated due to the number group connector or line choice connector containing the called line is made busy.

c. The (RO) relay is operated due to the call being a reorder.

d. The (CNL-2) relay is operated due to a receiver off the hook on the called coin line.

OUTGOING TRUNK GROUP OVERFLOW OS 601

A register is provided to furnish means for obtaining a record of the number of times that a call originated to the particular trunk group and the originating marker finds all the trunks busy. When the (TB) relay of the marker operates, it connects ground to the OF lead, causing the register to score.

On trunk groups that have two route relays, the OF terminal of the second choice route relay should be cross-connected to operate the register while the first choice route relay "OF" terminal is not cross-connected. This is to avoid falsely operating the overflow register in case only the first choice trunks are busy.

Under "Outgoing Trunk Group Peg Count," the (DMT) and (JD) relays will prevent false registrations due to test frame calls.

PERMANENT SIGNAL OVERFLOW OS 601

When an originating marker encounters an all-permanent-signal-holding-trunks-busy condition, it connects ground to the OF lead as explained in "Outgoing Trunk Group Overflow."

> The grounded OF lead operates the A relay which in turn operates the OFL registers.

CALL INDICATOR OVERFLOW ALARM OS 601

If an all-outgoing-trunks-busy condition is encountered by the originating marker to a call indicator trunk group, the marker grounds the OF lead. This operates the A relay which in turn operates the OFL register and it scores.

The operation of the A relay short circuits the T and R leads.

> The T and R leads shorted by the operated (A) relay causes the alarm at the call indicator office to function.

SUBSCRIBER'S LINE OVERFLOW OS 601

When it is described to record the number of times a particular subscriber's line is called and the terminating marker finds the line busy, four short-circuit plugs are inserted in one of each of the "TH", "H", and "U" jacks of a subscriber's line overflow register circuit, corresponding to the line number after which a short-circuit plug will be inserted in the office selection "OS" jack corresponding to the office in which the subscriber's line is located.

Insertion of the plug in the "OS" jack connects ground to a common start lead STA to the terminating marker so that when the marker recognizes a busy condition on any subscriber's line that marker will operate its (BBA) relay extending the STA lead ground to the ST lead operating the associated marker preference (MP-) relay.

When the marker encounters a busy condition on the subscribers line it causes the BBA relay to operate. This causes the MP- relay in subscribers line overflow circuit to operate followed by the operation of the HLD relay.

> Only the lowest-numbered (MP) relay can lock operated.
>
> The (HLD) relay removes the operating battery from the other (MP-) relays thus preventing other markers from seizing the overflow register circuit.

The marker BR-1 and BR-2 relays operate.

> The operation of the marker "cut-in" (BR-1) and (BR-2) relays closes leads TH-1, 2, 4, 8, H-1, 2, 4, 5, T-1, 2, 4, 5, U-1, 2, 4, 5, CI, OA, and OB leads to the overflow register circuit.

For the purpose of this description, assume the terminating marker is handling a call to SH-2-1234 and the overflow register circuit No. 1 has plugs inserted in TH-1, H-2, T-3, U-4 and SH-"OS" jacks.

With the (BR-1) and (BR-2) relays operated, recording relays (TH-1) to (U-5) of the register circuit operate corresponding to the leads found grounded in the marker.

The recording relays TH-1, H-2, T-1, T-2 and U-4 relays operate followed by the TC and T relays.

Relay (T) is a condenser-timed relay which is used to provide a definite time interval to permit all (TH-1) to (U-5) relays, which should operate, to be operated. The secondary winding of the (T) relay was energized as soon as the (HLD) relay operates causing it to operate to its normal or non-operated position.

The FR relay operates followed by the release of the TC relay.

The operation of relays (FR) causes (TC) relay to release. The release of the (TC) performs no useful function when the line number received is identified as the line to be recorded on the register if busy.

Operation of relay (T) closes ground through the contacts of the operated recording relays to the number selection jacks, and if the plugs in the jacks correspond to the called line number found busy, then the TH, H, TN, OFF and PH relays operate.

The LB register operates and scores.

The CO relay operates followed by the release of the MP-, HLD, the recording relays and the BR-1 and BR-2 relays in the marker.

Assume the line identified is one that is not being observed upon. The operation of relay (FR) will not cause the operation of a register and pulse help (PH) relay, but will release relay (TC). The release of the (TC) relay operates the (T) relay to its normal contacts; then the TR, TC, T and CO relays operate.

The time interval measured by the above operations is provided to permit operation of a register pulse help (PH) relay, if it is to be operated, before relay (CO) is operated to release the circuit.

GROUP BUSY REGISTERS

TERMINATING SENDER GROUP BUSY OS 601

When all subgroups of terminating senders are busy, all (TGB) relays are operated, closing ground through a chain circuit to the TGB lead which causes the (A) relay of the register circuit to operate, which, in turn, causes the register to score. The operated (A) relay also operates relay (TB) of the terminating trouble indicating frame. This lights the (TB) lamp and brings in an alarm.

DIALING OR "B" SENDERS GROUP BUSY OS 601

When all subgroups of "B" or "dialing" senders are busy, their (BGB) relays operate and the circuit functions for the terminating senders.

"A" SWITCHBOARD SENDER GROUP BUSY OS 601

When all subgroups of "A" switchboard senders are busy, all (SGB) relays are operated, closing ground through a chain circuit to the SG lead which causes the (A) relay of the register circuit to operate which, in turn, causes the register to score. The operated (A) relay also operates the (SB) relay of the sender make busy frame. This lights the (SB) lamp and brings in an alarm.

COIN CONTROL GROUP BUSY OS 601

When all subgroups of coin control circuits are busy, their (SGB) relays operate and the circuit functions for the "A" switchboard sender group busy.

TRUNK GROUP BUSY OS 601

When all trunks of a group are busy, the ground is removed from the PB lead associated with that group of trunks, releasing the (B) relay of the traffic register circuit. The release of the (B) relay closes ground to operate the group busy traffic register of that trunk group.

DISTRICT JUNCTOR GROUP BUSY OS 601

When the sender link and controller tests for idle district junctors and only one idle district junctor is found, relay (TM) will not operate, indicating that the last idle district junctor of the selected district junctor group is being used on this call.

When the sender link controller progresses far enough to operate relay (SL), ground is extended to the D lead to operate a group busy register associated with the district junctor group.

> The "D" lead is taken through the normal contacts of the (TE) relay so as to prevent false register operations on test frame calls.

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